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Factors Influencing The Performance Of Capsicum Under Protected Cultivation And Assessing Profitability

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Abstract: Vegetables are very susceptible to the effects of climate change, especially succulent pot plants like capsicum. Major issues can be caused by severe weather events, which include high temperatures, protracted droughts, sudden rains, heavy rainfall, strong storms, sea level rise, and the return of biotic stressors, such as diseases, weeds, and insect pests. These problems are further made worse by decreasing arable land, finite natural resources, low productivity, high input costs, labor shortage, low market pricing, and young people's reluctance to consider farming as a vocation. marginal and small-scale farmers are turning to protected farming, especially in greenhouses, as a solution to these problems. Protected structures are extremely helpful for capsicum because it is a low-volume, high-value crop. These structures provide growers with higher income in addition to reducing biotic and abiotic challenges. Nevertheless, in countries that are developing such as India, protected agriculture encounters challenges despite its lucrative potential. The obstacles to wider acceptance and commercialization include high initial costs, a lack of qualified support, a shortage of real building materials for covered structures, and natural disasters like cyclones and floods. This comprehensive examination addresses many facets of protected farming in capsicum with the goal of identifying issues and solving them with improved technology. The study has a strong emphasis on mulching, drip irrigation, fertigation, biotic stress management, and greenhouse methods.

Index Terms - Greenhouses, Drip irrigation, climate, temperature, Profitability, Stress

Introduction

The term "protected cultivation" refers to horticulture planting in the time of micro weather conditions surrounding the plant body is partially or completely regulated to meet the needs of the plant species being cultivated during their development (Chandra, 2001). The most modern method for producing mostly horticultural crops both narratively and assessable is protected culture, many times known as greenhouse cultivation, and it is come to be more popular. Broadly around the world within the past few ten years. Land and water conservation, high yields, and ecological characterize protected agriculture, also known as controlled environment agriculture (CEA)(Jensen 2002).

India is the second highest producer of vegetable crops in the world, after China. But, it was also noted that its vegetable production dropped short of meeting the necessity for balanced diet for every individual. Around the globe, vegetables are taken to be as health foods that can detect deficits in certain micronutrients and it is also increase the framer income.The vicennium have seen accumulation in the out put of vegetable in the whole world, relevant where the prize buying and selling of vegetable commerce now be superior to that of grains. Owing to their general sensitively to extreme weather conditions lesser yield s of vegetables are mostly caused by incising temperature s and restricted soil moisture, a problem that will only get adverse due to climate change(Glance 2018).

The botanical name for sweet paper is *capsicum annuum* in solanaceae family it include. Sweet paper consider to have originated from south America, specially in Brazil. It is a costly crop that is grown in the mid hills of Himachalipatnam and supplied to the lowlands. Black paper rich in vitamin A and C(Brhan KS,2018).It's original flavor and soft texture ,along with its abundance of vitamins and minerals given it a different place in Indian cuisine.

Climate variation is defined as a shift in the state of the climate that is detectable over a protected period of time,usually longer in larger geographical areas and that can be identified by changes in the meaning of the various climatic condition, like temperature, precipitation, relative humidity and the composition of atmospheric gases etc. and the changeability its properties(Cubasch et al.,2013).

I. Advantage of protected vegetable:

- Preserve the moisture content of the soil.
- Income in the off-deacon increased by 48%,but pesticide use also increased by 56%.
- Vegetable production in adverse climates can be managed using various protected production systems.
- Polyhouse production method hold on to promise in succeed in the demand for nutritious and healthy foods, as well as high quality, pesticide free green vegetable.
- In protected structures the expensive vegetable seeds are produced simply free from disease.
- It is achievable to grow more than one crop on the on the same plot of land .

II. TYPES:-

2.1.Net houses:-

It is the simplest and least expensive kind of changed structure are called net . houses. They shield the crop from pests and birds with a net.

2.2.Polyhouses:-

Compared to net houses, polyhouse offer superior weather protection because they are composed of a plastic container, they can also be heated and cooled.

2.3.Greenhouses

The most advanced kind of covered construction are greenhouses. They come in glass or polycarbonate building and can be outfitted with range of temperamental control mechanisms.

III.**Condition maintained in greenhouses:-**

There are four different types of environmental parameters maintained in a green house. These are:

- CO2
- Temperature
- Light
- Humidity

IV.Suitable condition in protected cultivation of capsicum:-

Basically, bell peppers are ever green plants that grow best in cool weather and are not very versatile to other environments. Farmer's facieses difficulties to produce high quality capsicum because of biotic and abiotic stress like disease, pest, light intensity and crop related variables. Owing to the doubtful nature of weather patterns, crops cultivated in open fields are frequently subjected to variations in temperature, humidity, wind direction and other factors that can negatively impact crop output. As well, the production of vegetables is obstructed by the restricted amount of land available for cultivation.

Due to the crops lateral spreading and setting of fruits at adequately less temperature gave an extremely benefit to the capsicum to grow in a protected structures like a greenhouse(Singh AK, 2003).Various abiotic factors, including strong sun radiation, intense surface winds and the biotic factors like insects and illness it can causes stress in open field crop cultivation (Kamaruddin R. 2007).Protected against from the two stars in the primary stage of growing capsicum is in the covered structure, mainly in the off-season. In spite of the fact that very profitable, capsicum farming is still in its early stages of transfer and expansion in farmers fields in India(BD and Nath et al.,2003).Concerning economic viability,yield,fruit,quality and appearance, it is worthy to grow capsicum under covered structure(murthy et al.,2009).

V. Factors influencing the performance of capsicum:-

5.1 Relative Humidity:-

Sudden changes in relative humidity have a bad impact on the plants capability to grow and mature. It is evident that a protected structure displays a advanced relative humidity than an exposed environment. Comparative humidity promotes best nutrition utilization by making more net energy available for crop development and spreading crop life under moisture stress conditions. Rising capsicums in a green houses is highest done with a higher relative humidity (Gill.2018).Extreme humidity of 94.5% was observed in the gait in tunnel, 90.1% in the logically ventilated polyhouse, and 88.5% in the net house structure. In polyhouse, a greater relative humidity of 88.50% than in the open field. In a green house, the relationship between relative humidity and temperature is inverse, and the levels of both can be adjusted to suit the needs of the crop plants (sajitharani,2016).Capsicum plants grow more positively under high qualified humidity levels of 80%.In an open field setting, squat humidity joint with high air temperature can lead to cell dehydration, which can forever harm the plant and stop its growing, resulting in less fruits per plant (Basavaraja et al.,2003). Higher air temperature joint with low humidity can lead to cell dryness, which can and enduringly harm the plant and growth halt that results in a decrease in the quantity of fruits shaped by each plant in an open field. Ginger started that in to the polyhouses, modest air temperatures between 21.45 c and 27.71 c and a better relative humidity of 88.50% support quick increased vegetative development, better-quality cellular elongation, fruit output, and cell multiplication in capsicum. A high relative humidity of roughly 80% has a good impact on the growth and development of cauliflower plants. Nevertheless, excessive heat and relative humidity inside polyhouses exacerbate powdery mildew attack, development, and spread during crop growth (Sabir and Singh,2013).

5.2 Temperature:-

A significant climatic component, temperature disturbs several physical functions in plants, with germinations in plants, including germination, transpiration, respiration, photosynthesis, growth, and flowering (Tiveli,1998).The temperature inside of covered structures is vital to the development of capsicum. Temperatures between 25 and 300c during the day and 18 and 200c at night are ideal for manufacturing capsicum. Temperature has an effect on fruit setting if it is higher than 350c or lower than 120c.The perfect nighttime temperature for flowering and fruiting in a greenhouse in 180c. The vast ovaries of the capsicum flower hamper self-pollination by pushing the anthers gone from the stigmas. Low nighttime temperatures reduce the quantity, viability, and vigor of pollen grains, which has an impact on capsicum production. Low night temperatures cause capsicum plants to produce underdeveloped, malformed fruits with few or no seeds due to improper pollination (Kato et al., 1989).Male sterile flowers with non-viable pollen are observed even when capsicum plants are exposed to no extremely low day/night temperatures of 18/150c,(Sawhney et al., 1985). Differences in day and nighttime temperatures have an impact on plant morphogenesis, internode length, and shoot adaptation. Bell paper fresh weight, leaf count, and fruit yield are all positively impacted by the average temperature during a 24 hour period (JC et al., 1988).Soil temperatures of 2 to 30 degrees Celsius are typically seen under polyhouse as opposite to open cultivation at altogether crop growth stages(JC et al., 2010).Low night temperature harm also affects the buildup of carbohydrates in emerging pollen before 3-4 days of an thesis (Rosenfeld K et al., 2004).plant exposed to low night temperatures (LNT) as opposed to optimal night temperatures (ONT) and high day temperatures(HDT) experience significant changes in total biomass, plant heights, number of leaves, sugar accumulation, and other vegetative and reproductive parameters (Pressman et al., 2006).These effects can be avoided by significantly raising daytime temperatures to 36+_20c.Vegitative development metrics in capsicum grown in polyhouse are better when root zone temperatures between 20 and 22c occur (Basavaraja et al., 2003). In open space condition, greater temperatures in air combined with a lack of humidity may give rise to dehydration in cells, which can cause lasting damage to the plant and stop its growth, resulting in less fruit per plant. Moderate air temperatures inside polyhouses between 21.45C to 27.71C with a prevalence of greater relative humidity promote rapid cell multiplication, better cellular elongation, higher vegetative development, fruit production in capsicums. Bigger air temperatures are better protected against by polyhouses (Naik MK et al.,2007)

5.3 Light intensity:-

For an inevitable process like photosynthesis in plants, light is necessary. The purpose to avoid leaves from losing and gaining dry matter, plants undergo a compensation point at limited light intensity, where the rates of respiration and photosynthesis are equal. Plant growth and development are flowering, are significantly influenced by light (Lee et al,.2008). Long stays of sunshine result in higher light intensity, which increase stomata action and supports more plant development and growth. In commercial greenhouse, light intensity of light by positioning it a metro over a crop. In commercial greenhouses, light intensity and photoperiod are regulated, which is a vital approach to promote. Reflective aluminum shade nets increases winter temperatures and reduce summer temperatures. They additionally enhance solar energy conservation and reflection by plant canopies via photosynthesis (Kittas et al.,2012).Shade net houses with a lower light intensity than natural sunlight have an effect on the productivity, quality, and fruiting period of vegetable crops (Nangare et al.,1991).The average light intensity inside a polyhouse, is 67.50k.Lux, which is 21.90% less than the average light intensity in an open air setting (86.50k lux) (Sajitharani 2016). Higher light intensity had a beneficial effect on capsicums growth in polyhouses (Sirgh et al., 2011).Growing capsicum under a photo selative shading net house results in higher fruit yield and quality over growing in an open field(ombodi et al.,2015). It was discovered that the main obstacles to using a shade net house for sweet paper production were low fruit set and a high frequency of bacterial wait disease, which is brought on by elevated relative humidity and low light level of 30,000 to 35,000 luminaries (Samanta 2016).

5.4Growing media:-

Growing media plays an essential component in the successful development of crops in protected farming. In recent years, coco peat along with additional organic growing media have grown fashionable. Vermicomposting, FYM, rock wool, peat, perlite, vermiculite, soil rite, as well as other substances are growing more and more essential than soil, which harbor's numerous hazardous microorganisms and acts as a haven for an array of insects and rodents. The copious amount of macro- and micronutrients that exist in organic growing media originates from their natural source, which is vital to the growth and development of plants. Growing the medium additionally improves the biological and physical health of the soil, in addition to the structure of the soil. In besides enhancing soil conditions, vermicompost as a media in capsicum plants provides macro- and micronutrients that boost plant development, metabolism, synthesis, and the accumulation of metabolites in plant tissues. Using growing media, i.e., soil + coco peat + vermicompost + FYM in a ratio of 2:1:0.5:0.5, Bijeta et al. investigated maximum plant height, maximum fruit length, average fruit weight, fruit yield, early flowering, minimum days to marketable maturity, and maximum harvest duration in capsicum. In addition, they discovered that maximum overall growth can be achieved with cocopeat,vermicompost, and FYM.Showed in capsicum, using vermicomposed alone and mixing it with FYM and green manure enhances plant growth traits (Roy et al., 2011). Grown in bags made of polythene with growing media peat, capsicum fruit size and weight increased significantly: Perlite: Sand in a 1:1:1 ratio, but peat media have a beneficial effect on increased yield, vitamin C content, total soluble solids (TSS), and fruit count (yildirim, 2013).

Plant density and spacing have a relationship with each other. Plant density decreases when space increases and vice varsa. Since there is less competition between the plants for light, water, nutrients etc. Wider plant spacing leads to smaller, stronger plants, but it can also worsen weed infestation. Since there is intense competition among plants for nutrients that are accessible, closer plant spacing creates taller plants, but the number of weeds is far lower. In greenhouses as well, the high density method is usually employed to optimize productivity through the effective use of inputs and natural resources. Better root spread and wider planting spacing efficiently use resources including water, nutrients, space, and light(Malik et al., 2011).

Proper spacing promotes healthy competition among the plants, which consequently produces a marketable yield of higher quality and reduces the time-consuming nature of inter-cultural operations under polyhouse circumstances. increased plant spacing improves the yield of fruits and seeds on capsicum plants(Dharmatti and Kulkarni, 1988). According to Singh and Naik, sweet pepper plants spaced 50 cm by 30 cm and 50 cm by 40 cm give the most fruit. Plant numbers of 4.5 plants/m2 yield over a plant population of 2.25 plants/m2, according to Guo et al.   In capsicum, closer spacing leads to the highest yield and lowest output per plant and vice versa(Savic V,1992) . A rise in plant population induces a decrease in the vegetative and reproductive production of capsicum(Gaye MML, 1992). indicates the best yield is produced by plants spaced 80 cm by 30 cm, and the largest fruit size in capsicum is produced by plants spaced 80 cm by 71.7 cm. Sweet pepper cultivars with closest spacing of 60 cm x 30 cm had larger fruit sizes and higher concentrations of N and P(Maya et al., 1997). Growing capsicums at an economical three shoots per plant with an 80cm × 30cm plant spacing is suggested. According to Mantur et al., during the summer, 45 cm × 45 cm plant spacing results in the greatest production of capsicum fruits, meaning there are more fruits per plant with a higher mean fruit weight. Closer spacing of 45 cm × 30 cm resulted in good quality and increased fruit yield in capsicum grown in polyhouse conditions, as described by Zende and Kumar and Chandra. A 45 cm × 45 cm plant spacing exhibited good output per unit area, which resulted to a higher yield in the production of capsicums. According to Maniutiu et al., 40000 plants/ha produce far more capsicums than 30000 plants/ha. According to Lone , a wider spacing of 60 cm by 45 cm is associated with early flower initiation, early fruit setting, early first harvesting, higher fruit length, fruit width, fruit weight, shelf life, pericarp its thickness, number of fruits per plant, and fruit output per plant.

5.5 Training and pruning :-

In capsicum cultivation, training and pruning techniques are employed to reduce apical dominance and enhance lateral growth, branching, flowering, and fruit production. After 30 days from transplanting, capsicum plants are trained and pruned using Hessian strings tied to a GI wire grid positioned above the plants. This method involves training the main stem and any new stems along the strings. The plants are pruned to maintain two to four branches per plant. Plants with two branches tend to produce fewer but higher-quality fruits suitable for export, while those with four branches yield more overall. The top of the plant is trimmed at the fifth or sixth node to encourage the growth of two branches, which are then further pruned to result in four branches spaced about eight to ten days apart. This approach helps balance nutrient distribution, with each node supporting one weaker and one stronger branch. According to Cebula (1995), capsicum plants with two shoots tend to produce larger fruit. Saen and Pathom's research on a bell pepper cultivar showed that four-branch pruning increased plant height, fruit weight, and fruit length. Maniutiu et al. and Dasgan and Kazim reported that capsicum plants are pruned in accordance with number of branches (one to four) that must be kept.According to Dasgan & Kazim, Alam, Awalin et al., different pruning mechanisms for capsicum, such as two, three, or four stems per plant, are advantageous for simple training methods, permit HDP, generate larger fruits, early ripening, early picking, and higher yields. Better fruit set, early fruit ripening, high yield, and large-sized fruit have been found in capsicum grown under greenhouse circumstances, according to studies by Jovicich et al. and Zende. According to Lee and Liao, double-stemmed capsicum plants produce the largest and most profitable fruit yields. starting with a greater share of large-sized capsicum fruits that have the maximum marketable fruit yield one plant per double-stem. According to Kumar and Chandra , growing Indra hybrid capsicum in a polyhouse with 45 cm x 30 cm spacing and 4 shoots per plant offers raised flower count, fruit count, yield, and benefit.

5.6 Mulching :-

Mulching is an important intercultural operation performed in growing plants, especially in horticultural crops. Plasticulture is quickly gaining traction in modern farming(Lamont,2005). Black plastic significantly increases the temperature of the soil, inhibits weed growth, and retains soil moisture(Maniutiu,2010). Mulch materials varying in thickness from 30 to 100 micron and varying in durability are used for horticultural crops. Mulch that produces infrared light raises soil warmth Silver and black plastic mulch comes next. Henry and Barbara found that black mulch had a 10C bigger soil temperature than white mulch.The temperatures of the soil are bigger under white and black mulch, 5-8oC and 1-4oC, respectively, than under sunlight. White plastic should only be used for soil solarization; it is never advised to use it with grown-up plants since it raises the soil temperature to ninety degrees Fahrenheit, which may be harmful to growth and development. In a greenhouse, colored plastic mulches raise soil temperatures by 3 to 5 degrees Celsius in the winter and drop surface soil temperatures by two to three degrees Celsius in the summer, promoting the off-season production of high-value vegetables, especially capsicum.Mulches such as silver and yellow promote plant survival and yield because they lower soil temperature. According to Jakhdhar's research, compared to bare soil, black mulch significantly improved the production by 20.7 to 29.8% and produced a 2.2 to 3.4°C higher soil temperature. Larger, more fruitful capsicum fruits with a thicker pericarp and a greater percentage of water are reported by Bowen and Frey. whenever polyethylene mulch is used for planting. The maximum number of fruits per plant, fruit weight, total fruit output, and early and marketable fruit yield are all recorded for capsicum plants grown in greenhouses covered with black polythene mulch. In their study, Kumar and Verma found that in polyhouse capsicum production, black polythene mulching combined with fertigation yields the highest plant height, number of flowers, number of fruits, fruit set percent, and yield per plant or per square metre. Due to reduced weed infestation and enhanced soil moisture conservation, Gill was able to accomplish excellent yields of capsicum under NVPH using silver black polyethylene mulching (30 micron thickness).

5.7 Fetigation :-

The most important component of precision farming is drip irrigation paired with fertigation, which promotes effective utilization of water and nutrients.improves crop yields and reduces the waste of water and nutrients. Fertigation is the precise management of water-soluble nutrients to the root zone of plants using irrigation water. This process aids in the dispensing of an adequate amount of nutrients at the right concentration for plant growth and development. According to Goh and Haynes and Salisbury and Ross, fertigation causes the creation of several metabolic intermediates, which leads to earliness in the reproductive phase. According to Patel and Rajput, the most effective way to manage plant nutritional needs is by fertigation, which involves bringing together water and nutrients at the proper concentration. According to Silber et al., fertigation enables plants to take in nutrients more easily, which has a positive connection between yield and correlation. According to Xu et al., phosphorus deficit may be overcome by high frequency fertigation. Locascio shown that fertigation with drip irrigation applied directly to the root rhizospere provides the best results as far as of precision, uniformity and efficiency in the administration of nutrients. Antony and Singhdhupe examined the greatest height, number of limbs, and yield of bell peppers grown with 100% drip irrigation. Silber et al. looked into the possibility that fertigation frequency increases might decrease the rate of blossom end rot disease in capsicum. Mantur et al. found that applying N to capsicum plants during the summer and Kharif results in increased fruit pounds, fruit yield per plant, and fruit results per m2Maximum plant height, flower number, fruit number, and fruit set were investigated by Kumar and Verma. In polyhouse production of tomatoes, fertigation with 250 kg NPK per hectare and black polythene mulching yield % and yield per plant or per square metre. Better dry matter buildup, fruit size, number of fruits per plant, initial yield, total yield, WUE, and benefit cost ratio are observed in capsicum growing under protected cultivation if there is an IW/CPE ratio of 0.75 and 60 cm plant spacing. The growth characteristics, yield characteristics, ascorbic acid content, and cost-benefit ratio (1:1.72) of capsicum is significantly enhanced by drip irrigation at 100% ET in addition to fertigation of 100% recommended N and K, as stated by Brahma et al. Higher doses of NPK significantly increase the quantity and quality of capsicum, including ascorbic acid and capsanthin content, according to Khan et al. According to Bassiony et al., this is because soluble plant nutrients remain in the soil throughout an active growth and development phase. In capsicum, a single application of NPK at a rate of 250 kg NPK ha-1 had a beneficial effect on vegetative growth indices such plant height and leaf count.

5.8 Biotic stress :-

Fresh fruit and vegetable toxicity has increased, the ecology is out of balance, and soil health decreased due to the ongoing and careless use of chemical pesticides. Due to the development of the pest resurgence problem, plants are currently the most vulnerable to an extensive variety of insects and diseases. In open field farming, worms, infections, and other biotic elements pose significant obstacles. In addition, under protected cultivation, capsicum is infected by mites, aphids, and fruit borer. One of the main diseases that affect capsicum grown under protected is bacterial wilt, which causes plants to rapidly wilt and die without showing any yellowing or spots on their leaves.Powdery mildew and damping off are also common diseases(Sindhu,2011). One of the most damaging plant parasites to the economy is the root-knot nematode (Meloidogyne incognita). nematodes that lead to the development of root-knot galls, which deplete the plant's nutrition and capacity for photosynthesis. However, the majority of the subsequent studies conducted by many scientists shows that protected agriculture produces more positive results than open fields, and this is the way to go. Under protected cultivation, it is possible to attain improved quality and a higher yield of vegetables(Bhatnagar et al.). Fruit rot and leaf blight are more rare in greenhouse than they are in open fields. High-value crops are shielded from an array of challenges, such as adverse weather conditions and insect pests, by plastic films and shade shelters, which also have an impact on the crop(Takte et al.). The smallest number of infections are observed in polyhouses, which shield crops from major stressors that are both abiotic and biotic. Singh et al. noted that it was significant rainfall and that an atmosphere of control was provided. In accordance with Kohnic et al. , there has been a noticeable drop in aphid and thrip (Frankliniella occidentalis) infection in greenhouses that grow peppers. When compared to other colour nets used in the production of sweet peppers, Yosepha et al. found that the yellow net significantly decreases the incidence of viral illness, thrips, and aphid infestation.

VI. Profitability:-

The environmental variables that can affect capsicum includes high temperatures, droughts, heavy rainfall, and biotic stresses (pests, diseases, and weeds). Protected structures, such polyhouse or greenhouses, offer a regulated environment that lessens these pressures.

The advantages of protected cultivation

- Higher Yield: When grown inside, capsicum produces significantly more than when it grows outdoors.
- Fruit of higher quality, more uniform in shape and colour, is produced under controlled conditions.
- Off-Season Production: Year-round production can happen because to protected cultivation, even in the off-seasons.

- Financial Compensation: Due to increased availability and quality, growers can command higher prices on the market.

VII. Conclusion:-

For high-value, low-volume crops like capsicum, restricted cultivation is always preferable to open field cultivation. A polyhouse with temperatures during the day between 25 and 300 degrees Celsius, nighttime temperatures between 18 and 200 degrees Celsius, 80% relative humidity, and light intensity between 35,000 and 55,000 lux is conducive to greater capsicum performance. The majority of researchers suggested the following: fertigation of 100% RDF @150:150:150 kg NPK/ha along with the use of 30 t/ha FYM during final media preparation with integrated pest management encourages higher a vegetative growth, yield and quality parameters, suffers less insect and disease attack, and is a feasible spacing of 45-60 cm x 30-45 cm..protected cultivation of capsicum offers a pathway to address climate challenges, improve yields, and boost socio-economic development for farmers.

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