**EFFECT OF WEED CONTROL METHODS ON SWEET PEPPER *(Capsicum annuum L.)***

**A RESEARCH PROJECT**

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**NOVEMBER, 2023**

**CHAPTER ONE**

**INTRODUCTION**

* 1. **Background of the Study**

Sweet pepper *(Capsicum annuum)* is a flowering plant under the genus Capsicum and belongs to the family Solanaceae (Alvarado *et al.,* 2007). In Nigeria, it is also known as Ball pepper. It is relatively non-pungent with thick flesh and is the world’s second most important vegetable after tomato (AVRDC, 1989). Tropical South America, especially Brazil is thought to be the original home of the pepper (Shoemaker and Teskey, 1995). Small scale cultivation is found in peri-urban areas primarily for the supply to some city markets in Nigeria (Saha, 2001). Bell pepper is considered a minor vegetable crop in Nigeria (Hasanuzzaman, 1999). The popularity of sweet pepper is increasing day by day especially among the urban people because of its high nutritive value and possible diversified use in making different palatable foods. It is rich in capsaicin and has powerful antioxidant properties that may help works against inflammation (Alvarado *et al.,* 2007). Bell pepper is chosen because of its higher nutritive value and generally it contains 1.29 mg protein, 11 mg calcium, 870 I.U. vitamin A, 17.5 mg ascorbic acid, 0.6 mg thiamin, 0.03 mg riboflavin and 0.55 mg niacin per 100 g of edible fruit (Joshi and Singh, 1975). Sweet pepper *(Capsicum annuum L.)* is an economically important vegetable crop which is currently grown in about 8,522 ha, with total pepper production of 175,867 t and average pepper production in about 20.6 t ha-1 (Anonymous, 2015). Pepper is grown, in areas with a warm climate and a long growing season, which are also favorable to the growth of weeds, which results in increased weed pressure (Granberry and Colditz, 1990). Large scale production of this pepper is limited due to some problems in the production system, weed infestation and lack of familiarities to the growers. Sweet pepper production has some constraints which include flower dropping, poor fruit set, and susceptibility to viral diseases and it is a serious concern for the successful introduction of this crop (Saha, 2001). Sweet pepper is not a very competitive crop and weeds can significantly reduce pepper yield (Khan *et al.,* 2012). The weed infestation may reduce pepper yield by 60–80% (Nadagouda, 1995, Khan *et al.,* 2012). Weed management in pepper is required to minimize decrease of yield and quality of the fruit. Subhra and Pabirta (2014) noticed that the decrease in the pepper fruits/plant was proportional to the duration of weeds competition. In Nigeria, weed control in pepper are a combination of inter-row cultivation, hand weeding and herbicide application. Some farmers prefer to use soil applied herbicides before transplanting while others prefer herbicides application after transplanting. Application of herbicides before transplanting leaves the soil surface without weeds at the beginning of the growing season. According to Isik *et al.* (2009) immediately after transplanting, sweet pepper seedlings grow slowly whereas weeds emerge fast, grow rapidly and compete with the crop for nutrients, moisture, sunlight and growing space during all growing season. To improve sweet pepper (*Capsicum annuum*) growth and production capacity, there is need to evaluate an effective herbicide.

**1.2 Economic Importance of *Capsicum annuum***

*Capsicum annuum* is a major spice globally and it is used in diverse delicacies irrespective of culture nor religion (Cruz-Huerta *et al.* 2011). *Capsicum annuum* is a source of income to producers and store of wealth (Bradley, 2017). *Capsicum annuum* is an important crop not only because of its economic importance but also for the nutritional value of its fruits being a major source of natural colors and antioxidant compounds (Hwang *et al.,* 2014). The intake of these compounds I n food is an important health protecting factor, they have been recognized as being beneficial for prevention of widespread human diseases, including cancer and cardiovascular diseases when taken daily in adequate amounts (Bradley, 2017). These peppers are used either fresh or dried in preparation of traditional diets but they are commonly used fresh. Although pepper has been reportedly used as medicine in the management of arthritis pair, diabetic, neuropathy, post mastectomy and among others, there is paucity of information about the antioxidant capacity of the pepper varieties used as major condiments in the traditionally prepared diet in the South West of Nigeria (Hwang *et al.,* 2014). Hence, sweet pepper is important for both the producers, government and the consumers.

**1.3 Justification of the Study**

Where success of crop depends on many factors and effective weed management is one of most prior for a successful crop productivity. Favorable environmental conditions, proper spacing and liberal use of farmyard manure, chemical fertilizers and frequent irrigations encourage the weeds to grow vigorously and lead to severe weed competition particularly during early stages of *Capsicum annuum* growth. It has been estimated that losses in yield due to weeds alone vary from 10 to 70% depending upon the extent of weed infestation (Mani *et al.,* 1968). It is difficult to control weed manually because of poor efficiency of the labour in summer and rainy season besides heavy cost of manual weeding. There seems to be good scope to make use of selective herbicides control to attain season long control of weeds. The study is designed to investigate the feasibility of using different types of herbicides and rates as a weed control approach considering the growth and yield response of *Capsicum annuum.*

**1.4 Objective of the Study**

The objective of this study is;

* To determine the effect of Herbicides types on the yield and growth Response of *Capsicum annuum*

**CHAPTER TWO**

**LITERATURE REVIEW**

**2.1 Taxonomy of *Capsicum annuum***

Sweet pepper (Capsicum species) belongs to the Family Solanaceae, Genus Capsicum, and species annuum L., group of vegetables. Cultivated peppers are all members of the world capsicum species. There are an estimated 1,600 different varieties of pepper throughout the world with five main domesticated species that includes; *C. annum L., C. frutescens L. C. Chinenses., C. baccatum L.,* and *C. pubescens R.* (Bosland *et al*., 2012).

Kingdom: *Plantae*

Family: *Solanaceae*

Genus: *Capsicum*

Species: *Capsicum annuum*

**2.2 Agronomic Properties of Sweet pepper *(Capsicum annuum)***

**2.3.1 Planting**

The earliest period for seedling establishment for *Capsicum annuum* is when the soil and air temperatures at least meet the minimum requirements for plant growth. The latest seedling establishment period would be after allowance has been made for the growth and harvest periods to be completed before adverse conditions sets in (Cantwell, 2011). Due to the effect of certain factors being prevalent at specific locations, within each of these areas the planting times may be earlier or later (Granberry and Colditz, 1990). *Capsicum* is normally raised in nursery and transplanted but it can also be directly sown. It can also be raised on seed trays for improved germination and Seed Rate should be 100g per acre. The single most important factor when making a decision around plant population is the type of chemical spraying system- or method that the grower is going to use for the duration of the crop. Everything should be designed around this implement so as to get in between rows when spraying to effectively control pests and diseases. Plant population is around 30 000 plants per hectare (Starke, 2021).

**2.3.2. Fertilization**

During the production of sweet and hot peppers, correct fertilization is the single most important factor that determines the success of a crop. With good management practices these crops could be produced under a wide range of different conditions, however some growing conditions are more favourable than others (Starke, 2021). In order to calculate the correct nutrient requirement, the following aspects need to be available and taken into consideration: Nutrient withdrawal figures, Fertilizer used in the past on the specific area intended to be planted, Soil type, Soil analyses, Soil Acidity (pH), Quality of irrigation water and Micro elements (Starke, 2021). The ideal soil analyses or soil status for sweet pepper production should be: pH (H2O): 5.6 – 6.8, P: 30 – 60 mg/Kg (Bray1), K: 100 – 250 mg/Kg, Ca: 300 – 2000 mg/Kg, Mg: 120 – 300 mg/Kg, Na: 10 – 50 mg/Kg (Isik *et al.,* 2009; Starke, 2021*)*

**2.3.3 Climatic Requirement of *Capsicum annuum***

Climate is one of the most important factors when determining planting times. Production of a pepper crop depends on the length of a growing season with optimal temperatures (Starke, 2021). The plant itself stops growing at temperatures below 10° - 12°C, and at 6°C, the leaves can die and flower abortion will start. The same will happen when temperatures increase to over 35°C (Isik *et al.,* 2009) Temperature variation might result in poor fruit quality or reduced yields. Optimum temperatures would be: Day time (25 - 28°C) and Night time (16 - 18°C). A relative humidity between 65 – 85% is considered optimal. High relative humidity levels negatively influence pollen release and distribution on the stigma. High humidity creates a favourable environment for the development of several foliar diseases (Horvitz and Cantalejo, 2014).

**2.3.4 Soil Requirement of *Capsicum annuum***

Certain criteria have to be satisfied in terms of the soil properties to make sweet pepper commercially viable. These factors include: Nutrient composition, Compaction Effective soil depth, pH, Crop rotation, Herbicide residues and Water holding capacity (Granberry and Colditz, 1990). All these factors can have major influences on the resulting yield. The soil must permit adequate root growth to support the plant and supply water, oxygen and mineral nutrients and must be free of toxic elements. The rate of root growth is dependent on the degree of compaction or bulk density of the soil (Frary, 2012). The degree of soil compaction varies with soil type and location (Granberry and Colditz, 1990; Starke, 2021). The rate of aerial and root growth of plants increases with the oxygen contents of the soil. Root density is highest where there is a high rate of diffusion. Root development of pepper plants can be extensive if soil water and plant conditions are optimal (Lownds *et al.,* 1993).

**2.4 Constraints of *Capsicum annuum* production in Nigeria**

The yield of *Capsicum annuum* in Nigeria is generally low due to the use of varieties that are of narrow genetic base which are grown on soils that are of inherent low fertility (Daunay *et al.*, 2001). The unimproved local cultivars commonly grown in the tropics with scanty plant stands, improper planting distance and lack of other improved agricultural inputs in the management of the crops has resulted in low yield (Law *et al.* 2009). However, in Nigeria, farmers get lower yield mainly due to the fact that *Capsicum annuum* is sensitive to a number of environmental stresses, especially extreme temperature, salinity, drought, excessive moisture and environmental pollution, improper planting distance, diseases and pests as well as weed infestation. Under the climatic conditions in Nigeria, *Capsicum annuum* is infested by a number of insect pests, the most destructive of which is the pepper shoot and fruit borer (ESFB, *Leucinodes orbonalis* Guen.). Despite heavy insecticide applications, significant yield losses occur on a regular basis (Ghosh *et al.,* 2003). Additionally, uncontrolled weed growth interferes with the growth and crop yields, hence the need for effective and sustainable herbicide (Shivalingappa *et al.,* 2014).

**2.5 Weed Management in *Capsicum annuum***

The weed infestation may reduce pepper yield by 60–80% (Nadagouda, 1995, Khan *et al.,* 2012). Weed management in pepper is required to minimize decrease of yield and quality of the fruit. Subhra and Pabirta (2014) noticed that the decrease in the pepper fruits/plant was proportional to the duration of weeds competition. Good weed control in *Capsicum annuum* begins the same as any other crop, before the crop is planted. Knowing the weed species in the field is the first step in effective weed management. The use of cultural, mechanical, and chemical weed control techniques in a coordinated manor to reduce the risk of weed interference with the crop is necessary (Bradley, 2017). In choosing the right herbicides to control the weeds in the field, herbicides that provide proper soil texture and organic matter in the field, and minimizes the risk of crop injury and maximize weed control should be considered (Hembree, 2015). Several effective herbicides are registered for use in transplanted *Capsicum annuum* (Bradley, 2017). Effective weed management in *Capsicum annuum* also begins with proper field selection and identification of potential weed problems (Bradley, 2017). It involves pre-irrigation and cultivation, proper land and bed preparation, sanitation, and proper selection of herbicides (Hembree, 2015). When combined with good cultural practices, available herbicides can control many of the weed species that are found in pepper fields. The choice of herbicide depends upon the weed species that are present and the cultural practices followed thereafter (Hembree, 2015).

***2.5.1 Pre-Emergence Herbicides***

Pre-emergence herbicides are applied to the soil and mechanically mixed with the soil or are irrigated into the soil before weeds emerge (Hembree, 2015). They are effective against germinating seeds before they germinate; these materials usually give some residual control of 3-6 months. Herbicides work best if they are applied when soil moisture is adequate for plant growth. Pre-emergence herbicides are effective against germinating seeds, not dry seeds (Bradley, 2017). Pre-emergence herbicides are not to be applied on wet soils, as compaction can occur (Hembree, 2015).

***2.5.2 Post-Emergence Herbicides***

Post-emergence herbicides are sprayed onto the foliage of the weeds after they have emerged (Hembree, 2015). Certain post-emergence herbicides are systemic, selective and are absorbed by the leaves and stems of the weeds and translocated in the plant. Other post-emergence herbicides are strictly contact and only kill the leaves/plants they come in contact with (Bradley, 2017). Post-emergence herbicides work best on non-stressed plants, which absorb and translocate the material more readily than stressed plants (Hembree, 2015). Some common examples of post-emergence and it trade name include:

* Sethoxydim - *Trade name: Poast®,*
* Clethodim - *Trade name: SelectMax®*
* Halosulfuron - *Trade name: Sandea®*
* Bentazon - *Trade name: Basagran®*

*Source; Greg and Beth (2019).*

**2.6 Effect of Herbicides and Rates on Sweet pepper (*Capsicum annuum*)**

The productivity of any crop depends on many factors and effective weed management is one of most prior for a successful crop. Favorable environmental conditions, proper spacing and liberal use of farmyard manure, chemical fertilizers and frequent irrigations encourage the weeds to grow vigorously and lead to severe weed competition particularly during early stages of its growth (Hembree, 2015). It has been estimated that losses in yield due to weeds alone vary from 10 to 70% depending upon the extent of weed infestation (Mani *et al.,* 1968). It is difficult to control manually because of poor efficiency of the labour in summer and rainy season besides heavy cost of manual weeding. There seems to be good scope to make use of selective chemical and cultural control to attain season long control (Hembree, 2015). Sumeet *et al.,* (2017) reported that the treatment comprising with post-emergence application of paraquat @ 0.15 kg/ha at 45 days after transplanting (DAT) showed better result than other treatment (mulching) with yield of 96.72% and these findings was similar to Nadagouda, (1995). Shivalingappa *et al.,* (2014) also revealed that pendimethalin @ 1.5 kg a.i. ha-1 had more significant effect among treatments which results less number of weeds, less dry weight (g), high weed control efficiency (WCE %), and increased in morphological, biochemical parameters, yield attributes while comparing with all the treatments at 30, 60, 90, 120 DAT followed by pendimethalin @ 1.0 kg a.i. ha-1

**CHAPTER THREE**

**MATERIALS AND METHODS**

**3.1 Study Area**

This study was carried out at the Teaching and Research farm of Faculty of Agriculture, Akwa Ibom State University. Obio Akpa Campus, Oruk Anam Local Government Area, Akwa Ibom State. The area lies between latitude 4030’N and 50 00’N and longitudes 700 30’E and 800 00’E (SLUS-AK, 1989). It records annual rainfall of about 2500mm. the rainfall lasts between April and November usually with a break in august which last for about 2 weeks (termed August break). Temperature range is between 22.5-30.7OC. The relative humidity is about 78%. The soil is sandy loam (SLUS-AK, 1989).

**3.2 Experimental Design and Treatments**

The experiment was laid out in a randomized complete block design (RCBD) with three treatments and three replications. Each sub-plot measured of 2m x 1m and consisted of 3 rows as shown in figure 1, having a net plot of 9m x 7.5m. The herbicides types used are; primextra, pendimethalin and butachlor in the rates of 0.0, 1.0, 2.0, 3.0 kga.iha-1

**7.5m**

**Control Hoe Weeding Herbicides**

**1.5m**

**2m**

**1m**

**9m 2m**

**1m**

**2m**

**Figure 1: The Layout of the Experimental Treatments and Design**

**3.3 Soil Sampling**

Prior to planting the soil was randomly sampled at the depth of 0.15cm at three different location or spots in the area. The soil samples were bulked together to obtain a representative sample, the representative sample was air dried and sieved with 2mm sieve before being taken to the laboratory for analysis.

**3.4 Agronomic Practices**

**3.4.1 Land Preparation**

The field was cleared manually using cutlass and tilled with spade. Stumping (if any) and beds making was done manually through the use of spade.

**3.4.2 Planting**

Planting material was done using *Capsicum annuum* seeds and the pre-emergence herbicides (Primextra) applied before germination of the crop.

**3.4.3 Fertilizer application**

Organic manure in the form of poultry dung was used alongside Compound Fertilizer (N: P: K 15:15:20) was applied at the rate of 50 g/vine (500 kg/ha) by ring application, 4 weeks after planting.

**3.4.4 Weeding**

Removal of unwanted plants or weed was done by application of post-emergence herbicides (Pendimethali and Butachlor) at the rates of 0, 1.0, 2.0 and 3.0 kg a.i. ha-1

**3.4.5 Harvesting**

Harvesting was done manually using sharp knife at 30, 45 and 60 day intervals.

**3.5 Data collection**

**3.5.1 Growth Parameters**

* **Plant height (cm)**

The plant height was measured from the base of the plant to the terminal growing point of the main stem at 30, 60, 90, 120 days after transplant. The average plant height was worked out and expressed in centimeters.

* **Number of leaves per plant**

The number of leaves per plant was measured at 30, 60, 90, 120 days after transplant for three rows plants and then mean was worked out.

* **Number of branches per plant**

The number of branches per plant at 30, 60, 90, 120 days after transplant was counted for three rows plants and then mean calculated.

**3.5.2 Yield Parameters**

* **Total number of fruits**

The total numbers of fruits from three tagged plants was counted in all the pickings and the average total numbers of fruits per plant for each treatment was worked out.

* **Fruit weight (g /fruit)**

Five numbers of fruits from each treatment was weighed and worked out for single fruit weight and expressed in grams.

* **Fruit yield (t/ha)**

The fresh fruit yield from the net plot area was taken to calculate the unit yield per hectare.

**3.6 Data Analysis**

All the data obtain were analyzed using One Way Analysis of Variance (ANOVA). Significant means will be separated by applying Duncan multiple range as outlined by Duncan (1955).

**REFERENCES**

Aizat WM, Able JA, Stangoulis JCR, Able AJ. (2013). Characterization of ethylene pathway components in non-climacteric capsicum. *BMC Plant Biology,* 13:191.

Alvarado-Casillas S, Ibarra-Sánchez S, Rodríguez-García O, Martínez-González N, Castillo A. (2007). Comparison of rinsing and sanitizing procedures for reducing bacterial pathogens on fresh cantaloupes and bell peppers. *Journal of Food Protection,* 70:655–660.

Andrews, J. (1984). Peppers: The Domesticated Capsicums; University of Texas Press: Austin, TX, USA.

Andrews, J. (1993). Diffusion of meso american food complex to southeastern Europe. Geograph. Rev., 83, 194–204.

Anonymous. (2015). Agricultural statistic of Republic of Macedonia, Ministry for agriculture, forestry and water utilization, Government of RM, Skopje, R Macedonia

AVRDC (1989). Tomato and the pepper production in the tropics. AVRDC., Taiwan. 585p.

Barboza, G.E.; Carrizo García, C.; Leiva González, S.; Scaldaferro, M.; Reyes, X. (2019) Four new species of Capsicum (Solanaceae) from the tropical Andes and an update on the phylogeny of the genus. *PLOS ONE*, 14, e0209792.

Borovsky Y, Oren-Shamir M, Ovadia R, de Jong W, Paran I. (2004). The A locus that controls anthocyanin accumulation in pepper encodes a MYB transcription factor homologous to Anthocyanin2 of Petunia. *Theoretical and Applied Genetics,* 109:23–29.

Bosland, P.W.; Votava, E.J. (2012.). Peppers: Vegetable and Spice Capsicum, 2nd ed.; CABI Publishing: Wallingford, UK.

Bradley A. M. (2017).*Weed Management in Tomatoes, Peppers and Eggplant*. Rugers Agricultural Research & Extension Center, Bridgeton, NJ 08302

Cantwell M. (2011). Bell pepper. Recommendations for maintaining postharvest quality. http:// ucanr.org/sites/postharvest/pfvegetable/BellPepper/

Carrizo C.; Barfuss, M.; Sehr, E..; Barboza, G.; Samuel, R.; Moscone, E.A.; Ehrendorfer, F. (2016) Phylogenetic relationships, diversiﬁcation and expansion of chili peppers *(Capsicum, Solanaceae). Ann. Bot.,* 118, 35–51.

Cruz-Huerta N, Williamson JG, Darnell RL. (2011). Low night temperature increases ovary size in sweet pepper cultivars. *HortScience*. 46:396–401.

Daunay, M., Lester, R., Ano, G. (2001). *Cultivated eggplants. In:* *Tropical Plant Breeding*, Charrier, A., Jacquot, M., Hamon, S., Nicholas, D. (eds.). Oxford University Press, Oxford, U.K. pp. 200–225.

Díaz-Pérez JC. (2014). Bell pepper *(Capsicum annum L.)* crop as affected by shade level: fruit yield, quality, and postharvest attributes, and incidence of Phytophthora blight (caused by Phytophthora capsici Leon.). *HortScience*. 49:891–900.

Dogan A, Selcuk N, Erkan M. (2016). Comparison of pesticide-free and conventional production systems on postharvest quality and nutritional parameters of peppers in different storage conditions. *Scientia Horticulturae,* 207:104–116.

Elibox W, Meynard CP, Umaharan P. (2015). Morphological changes associated with postharvest fruit deterioration and physical parameters for early determination of shelf life in *Capsicum chinense* Jacq. *HortScience. 50*:1537–1541.

Erin M. O’Donoghue, David A. Brummell, Marian J. McKenzie, Donald A. Hunter & Ross E. Lill (2018) Sweet capsicum: postharvest physiology and technologies. *New Zealand Journal of Crop and Horticultural Science,* 46:4, 269-297

FAOSTAT. About Trade: Crops and Livestock Products. (2020). Available online: http://faostat.fao.org/site/535/default.aspx# ancor (accessed on 19 April 2022).

Frary A. (2012). *Physiology of metabolites*. In: Russo VM, editor. Peppers: botany, production and uses. Cambridge (MA): CAB International; p. 176–188.

Gazipur. Sasaki, H., Yano, T. and Yamasaki, A. (2005). Reduction of high temperature inhibition in tomato fruit set by plant growth regulators. *JARQ*, 39:135-138.

Ghosh, S.K., Laskar, N., Senapati, S.K. (2003). Estimation of loss in yield of brinjal due to pest complex under Terai region of West Bengal. *Environment and Ecology*, 21, 764-769.

Gomez-Garcia MDR, Ochoa-Alejo N. (2013). Biochemistry and molecular biology of carotenoid biosynthesis in chili peppers *(Capsicum spp.).* *International Journal of Molecular Sciences,* 14:19025–19053.

Hasanuzzaman, S.M. (1999). *Effect of hormone on yield of bell pepper (Capsicum annum L.)* MS thesis, BAU, Mymensingh.

Hembree, k. (2015). Young eggplant plants, *Solanum melongena*. Statewide Integrated weed and Pest Management Program, University of California Agriculture and Natural Resources.

HorvitzS, Cantalejo MJ. (2014). Application of ozone for the postharvest treatment of fruits and vegetables. *Critical Reviews in Food Science and Nutrition,* 54:312–339.

Hwang D, Jeong H-J, Kwon J-K, Kim H, Kang S-Y, Kang B-C. (2014). Phenotypic variants among ethyl methanesulfonate M 2 mutant lines in *Capsicum annuum*. *Plant Genetic Resources,* 12: S141-S145.

Isik, D., Kaya, E., Ngouajio, M. and Mennan, H. (2009). Weed suppression in organic pepper *(Capsicum annuum L.)* with winter cover crops. *Crop Protection,* 28, 356–363.

Joshi, M.C. and Singh, D. (1975). Chemical composition in bell pepper. *Indian Hort*., 20: 19-21.

Kader A. (2002). Postharvest technology of horticultural crops. Publication 3311. 3rd ed. Oakland: University of California.

Khan, A., Muhammad, S., Hussain, Z. & Khattak, A.M. (2012). Effect of different weed control methods on weeds and yield of chillies *(Capsicum annuum L.).* *Pakistan Journal of Weed Science Research*, 18, 71–78.

Law-Ogbomo K. E., Egharevba R. K. A. (2009). Effects of planting density and NPK fertilizer application on yield and yield components of Eggplant (*Solanum melongena)* Mill. *World Journal of Agricultural Sciences*; 5(2):152-158.

Lownds NK, Banaras M, Bosland PW. (1993). Relationships between postharvest water loss and physical properties of pepper fruit *(Capsicum annuum L.).* *HortScience*. 28:1182–1184.

Mani V S, Gautam K C and Chakrabority (1968). Losses in crop yield in India due to weed growth. *PANS* (C) 142: 141-58.

Nadagouda B T (1995) *Integrated weed management in drill sown onion* (*Allium cepa* L.). M.Sc. (Agri.) Thesis, Univ. Agric. Sci., Dharwad, Karnataka (India).

Saha, S.R. (2001). *Heat tolerance in sweet pepper.* PhD thesis, BSMRAU,

Sharma, P.P., Lankroo, G.M. and Arya, P.S. (1988). Chemical weed control in bell pepper *(Capsicum annum L.).* *Vegetable Science* 15, 113–119.

Shivalingappa S., Eugenia P., Santosh S., Umesh T. (2014). Effect of herbicides on weed control efficiency (WCE) and yield attributes in brinjal (*Solanum melongena L*.). *Journal of Agriculture and Veterinary Science,* 7 (6):2380--2319.

Shoemaker, J. and Teskey, B. (1995). Practical Horticulture. John Willy and Sons, Inc. New York. p. 371.

SLUS-AK (1989). Soils and land use studies, Government print office, Uyo, Akwa Ibom State Soil Survey Staff 1994. Key to soil Taxonomy Soil Management Support Serviec (SMSS). Technology. No.19.pp306

Stall, W.M. & Gilreath, J.P. (1996). *Evaluation of pepper tolerance to selected preplant herbicides.* Proceedings of the Florida State Horticultural Society 109, 187–190.

Starkes A. (2021) Sweet & Hot Peppers Production Guidelines

Subhra, S. & Pabitra, A. (2014). Weed management in transplanted chilli. *Indian Journal of Weed Science* 46, 261–263.

Sumeet S., Kulbirsingh, D., Khurana S. and Sardana V. (2017). Effect of Different Weed Management Practices on Growth and Yield of Brinjal (*Solanum melongena* L.). *International Journal of Current Microbiology Applied Science,* *6*(11): 3124-3129

Yoshida C, Takahashi M, Iwasaki Y, Furuno S, Matsunaga H, Nagata M. (2014). Factors affecting color development in sweet pepper *(Capsicum annuum L.)* fruit harvested at breaker stage of mature-green fruit. *Horticulture Research (Japan),* 13:155–160.

Zhigila DA, AbdulRahaman AA, Kolwole OS, Oladele FA. (2014). Fruit morphology as taxonomic features in five varieties of *Capsicum annuum L. Solanaceae*. *Journal of Botany*, 540868.