

Research Achievements Of Hot Pepper (Capsicum Species) and It Agro-Ecological Requirements in Ethiopia a Review

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Abstract

Hot pepper is an important spice and vegetable crop in Ethiopia. Its production is constrained by a number of problems among which climatic condition is the primary. The amount rain fall temperature humidity the solanaceous groups of vegetables including hot pepper generally are sensitive to environmental conditions. The amount of rain fall required depends on the altitude of the environment, wind speed sunshine hour, which in turn is influenced by a number of genetic and environmental variables. In the absence of any other production constraints, suitable climatic condition and yield of hot pepper are closely related. Pepper, like other crop produces well when it is grown in good environmental condition. Farmers produce hot pepper in different environment without considering the suitable environment. The yield of hot pepper varies year to year; this indicates that pepper crop need intensive care and management for high return per unit area and also appropriate environmental condition. So in order to produce good hot pepper with the required amount of capsaicinoid content it is butter to grow at temperature range of 17.5-28oc. at low altitude hot environment give high capsaicinoid content and in high altitude / Low humidity and high temperatures will cause abscission of buds, flowers and small fruits.

Introduction

Hot pepper (Capsicum species) belongs to the family of Solanaceae and originated in the new world tropics and subtropics (Mexico, Central America and Andes of South America) over 2000 years ago [2]. The Capsicum genus consists of approximately 22 wild species and five domesticated species, which include L., C. baccatum, L C. annum L., C. frutescens L., C. chinenses, and C. pubescens L. The C. annum complex, which contains three closely related species, C. annum, C. frutescens and C. chinenses are the most widely grown in the Americas and world-

wide. *C. frutescens* and *C. chinenses* are cultivated in Africa and Asia as spice crop, as intact fruits or for their oleoresin content. The other two species namely *C. baccatum* and *C. pubescens* are predominantly confined to Latin. *C. annum* has been domesticated in the highlands of Mexico, and includes most of the Mexican chili peppers, most of the hot peppers in Africa and Asia and the various cultivars of sweet peppers grown in temperate countries America [2].

Next to tomato hot pepper (*Capsicum annum* L.) is the world's most important vegetable crop and uses as fresh, dried, vegetable, spices, and condiments [6]. Hot pepper is a warm season, high-value crop important in the local dishes, Karia, berbere, and processing industries as a coloring agent and raw material for the export market in the form of oleoresin [2].

It was introduced to Ethiopia by the Portuguese in the 17th century [10]. Both sweet and hot peppers are processed into many types of sauces, pickles, relishes and canned products. The proliferation of ethnic restaurants and food products from such as Mexico, India and Thailand has positively influenced the demand for peppers throughout the world.

Production Status of Pepper in Ethiopia

In Ethiopia, the crop is cultivated at diverse ecological zones from sea level to 2000 m.a.s.l under rain fed and irrigated conditions. Whereas chili and sweet pepper are grown in lower altitudes relatively in warmer areas than for hot pepper and is mainly grown in state farms for export. Birds' eye chili, which is the most pungent of all the peppers, is not in great demand, though few plants are commonly found around the homesteads in high rain fall warmer areas of the country [9]. In our country a, the total area under hot pepper production for green pod has enhanced from 54,376 hectares with the total production of about 770,349 quintalsto 81,544 hectares through 2003/04-2005/06 years.

The limited quality and quantity of pepper production in the world is largely attributed to abiotic and biotic stress. Abiotic factors affecting pepper productions include various environmental factors such as temperature, soil, humidity, light intensity and moisture. Temperature along with humidity is playing an important role in pepper production. Many researches stated that the maximum set of bell or sweet pepper occurs at temperatures of 18°C to 24°C, but temperatures below 16°C and high temperature above 32°C prevent fruit set. Temperature can also affect fruit quality; best fruit color is realized at temperatures from 18°C to 24°C.

Low humidity and high temperatures will cause abscission of buds, flowers and small fruits. Night temperatures above 22°C lead to poor fruit set. Irregular rainfall Irregular rainfall distribution during fruit development exposes pepper to blossom end rot disorder. During the same period water stress lead to flower and fruit abortion [4].

Cultivation and Importance of hot pepper

Capsicum fruits are used in the form of fresh, dried or processed, as table vegetables and as spices or as condiments, it increases the acceptance of the insipid basic nutrient foods. The nutritional value of hot pepper merits special attention, as it is a rich source of vitamin A, C and E. Both hot and sweet peppers contain more vitamin C than any other vegetable crops. Oleoresins of paprika and *Capsicum* are the two important extracts of pepper (Yemane, 2017).

Red pepper it is an annual crop which grows at an altitude from 1400 up to 2100 m.a.s.l. Growing pepper requires soil that is well drained and rich in organic matter, as well as 600 up to 650 mm rain fall. It grows well on well-prepared soil that is free from perennial weed. It is propagated by raising seedlings in a nursery. Depending on the area, harvesting starts five to six months from transplanting. Planting is

carried out in the beginning of the main rain season[9].

Soil fertility decline and a resultant nutrient deficiency is the most yield limiting factor for vegetable production in different agro-ecologies of Ethiopia, of them the major limiting ones are N, P and other macro and micronutrients such as K, S, B and Zn deficiencies. Those deficiencies occur on high lands of Ethiopia because of high rain and frost attack is one of limiting in high land and too humid areas.

Hot peppers like most other plants, needs well drained, moisture holding loam soil (sandy loam) containing some organic matter. A pH of 6.5-7.5 is suitable and the land should be level to 0.01- 0.03 % slope to allow adequate drainage and prevent root diseases. Adequate water supply is essential. Water stress can lead to abscission of fruit and flowers, especially when it occurs during flowering and reduces yield through reduced pollination. The extreme case can result in increased risk of diseases. Poorer soil types and water stress are believed to produce poor quality and unmarketable pod [7].

The attitude of growing area affect the capsaicinoid content of hot pepper, weather conditions, growing conditions, and fruit age also have effect on capsaicinoid content of hot pepper. Plant breeders can selectively develop cultivars with varying degrees of pungency. Also, growers can somewhat control pungency by the amount of stress to which they subject their plants. More specifically, any stress to the hot pepper plant will increase the amount of capsaicinoid level in the pods. Pungency is increased with increased environmental stress. A few hot days can increase the capsaicinoid content significantly. In New Mexico, it has been observed that even after furrow irrigation, the heat level will increase in the pods. The plant senses the flooding of its root zone as a stress, and increases the capsaicinoid level in its pods. If the same cultivar was grown in both a hot semi-arid region and a cool coastal region, the fruit harvested from the hot semi-arid region would be contain higher capsaicinoid than that of the fruits harvested in the cool coastal climate (Yemane,2017).

Water requirement of red pepper

The water shortage during the period between flowering and fruit development decrease final fruit production some reports that continuous water stress significantly reduced total fresh weight of fruit, and the highest marketable yield was found at irrigation of 120% and the lowest at 40% evapotranspiration (ET). This indicates that total pepper yield was less at lower levels of irrigation [9]. Throughout the world, since the available water for agriculture is generally limited, the knowledge of the relationship between yield and quality of the product and irrigation regimes is an important factor to maximize the benefit of the available water supply.

Effective irrigation is essential to obtain the best yields of the fruit of the right size. The soil must be kept moist to a minimum depth of 45 cm. During the first 2 weeks after transplanting, the plants should be irrigated twice or three times per week for the transplants to become established, thereafter, once or twice per week depending on climatic conditions and soil type is advisable [9].

Research achievements of hot pepper in different parts of Ethiopia

As experiment that was conducted at Gatto Kebele Farmer training Center (FTC) which is found in Segen People's Zone of Derashea Woreda, South-Eastern Ethiopia. The area has an altitude of 1142 m.a.s.l. The maximum and minimum mean annual temperatures are 27^oc and 21^oc respectively. Sandy loam with pH of 5.4 is the character of the soil where the experiment was conducted. The area receives 1200mm average rainfall annually. The researchers gain the following finding. Table 1

As shown above the research conducted well in this type of agro climatic condition and It is advisable

that producers around the study area should have to use Backo local variety for better performance and Backo provides high yield in both cropping year with average fresh and dried fruit yield of 107.07Q/ha and 16.775Q/ha. [1].

The maximum and minimum rainfall is 1200 mm and 900 mm recorded at Boke district. Daro and labu district has the mean annual minimum and maximum temperature of 14 and 26°C were recorded and an average of 160C while meaning annual minimum and maximum temperature 13.56°C and 25°C, at Boke district, respectively In two districts of study areas, the rainfall is erratic; onset is unpredictable, its distribution and amount are also quite irregular. Consequently most “kebele” frequently face a shortage of rain; hence moisture stress is one of the major production constraints in the district. The pattern of rainfall is bimodal and its distribution is mostly uneven in two districts. Generally, there are two rainy seasons: the short rainy season “Belg” lasts from mid-February to April whereas the long rainy season “kremt” is from June to September.

Water and requirement of hot pepper can be varied from location to location depending on different factors such as soil and other agro-ecologies. For sustainable production of hot pepper for a particular area, specific fertilizer recommendation is very crucial in suitable agro ecologies. Highest marketable yield was obtained in the above agro ecologies (2.05 t/ha)/20.5Q/ha [3].

The other field experiment was conducted at Woramit horticultural research and training sub-center. It is located at 563km far from Addis Ababa in the Northwestern part of Ethiopia at Bahir Dar. The altitude of the study area is 1800 m.a.s.l with annual rainfall of about 800 to 1250 mm. Monthly mean minimum and maximum temperature is 6.2°C in January and 29.5°C in April, respectively. The soil at this experimental site is Nitosol with moderately acidic (pH 6.4) (Birhanu *et al*, 2017).

The other study was conducted at Assosa Agricultural Research Center (ASARC) farm during 2017/18 cropping season, which is located in Assosa District of Benishangul-Gumuz Regional State, western Ethiopia.

It is situated at an altitude of 1553 m a.s.l. The study area is characterized by hot to warm moist lowland plain with uni modal rainfall pattern. The rainy season starts in middle March and lasts to the end of October with maximum rainfall received in the months of June to September. The total annual average rainfall is 1316 mm. The soil type of the study area was characterized as Nitisoil .The results showed that the highest marketable pod yield (2.22 t ha⁻¹) was obtained. With the above agro ecology researchers gain such amount of result [7]. Figure 1

Experiment it was conducted in Humera Agricultural Research Center experimental site, Northern Ethiopia for two years 2011/2012 and 2012/2013 cropping calendar under irrigation show that. From the six hot pepper varieties evaluated Jeju scored highest marketable green pod yield (19.47 t ha⁻¹), which was statistically at par with yield of Marecofana (19.35 t ha⁻¹).

The experimental site is located at 14° 06' N latitudes and 38° 31' E longitudes with an altitude of 604 meter above sea level. It has chromic vertisol black color. Agro-ecologically it is described as hot to warm semiarid plain sub agro-ecology (SA1-1). The mean maximum temperature varies from 42°C in April to 33°C in August, while the mean minimum temperature is from 22.2°C in May to 17.5°C in July[8]. Table 2

As the above experiment shows agro ecologically similar to this site are better to the farmers to produce Jelu and Markofana type of varieties.

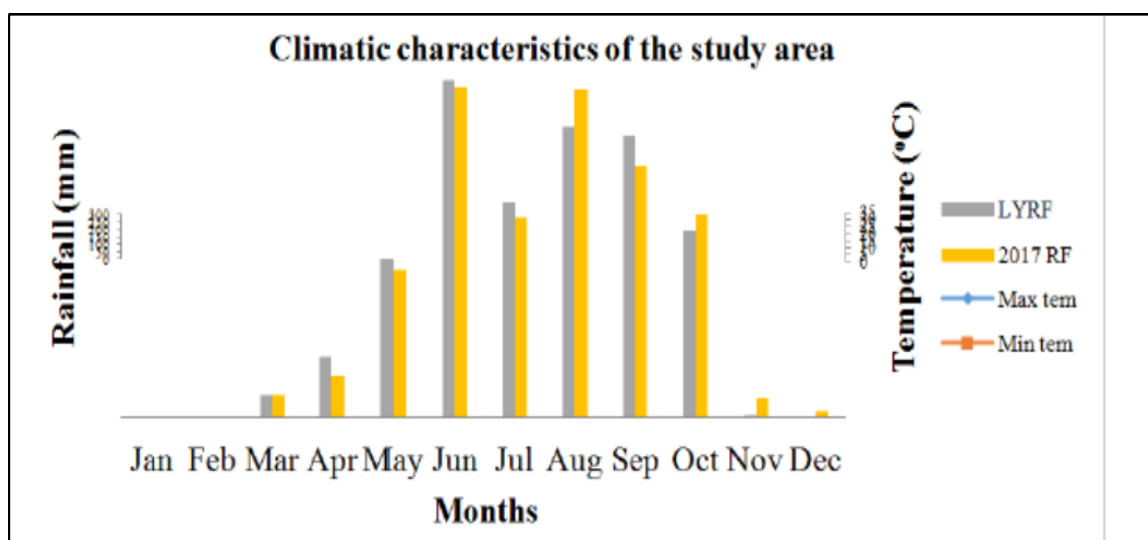
Deficit Irrigation in system to hot pepper

The experimental site is situated in the eastern part of Benna-Tsemay Woreda at Enchete kebele a distance

Table 1. the overall mean values of fresh and dried yield of hot pepper.

Treatments	2013				2014			
	SC	FL	FD	NFPP	SC	FL	FD	NFPP
Marekofana	23.4	9.0	2.3	60.4	28.6	8.8	1.72	38.04
Backo local	23.6	11.1	1.7	113.2	27.4	9.44	1.78	53.56
Odaharo	21.8	8.9	1.5	87.7	25.8	8.71	1.74	37.0
Halaba local	21.0	12.5	2.5	46.2	27.4	8.83	1.65	35.56
LSD	4.7	1.2	0.18	24.6	3.07	1.87	0.53	9.84
CV(%)	15.3	9.0	6.3	21.9	8.17	15.20	22.31	13.5
P<0.01	NS	**	**	**	NS	NS	NS	**

- SC, stand count: FL, Fruit length(cm): FD, Fruit diameter(cm): NFPP, Number of fruits per plant
- ** indicates highly significant differences among means, whereas * belongs significant differences among means
- NS, belongs to no significant differences among means



2. Long term (2011-2017) average rainfall and temperature and one year (2017) rainfall of

Figure 1. Long term (2011-2017) average rainfall and temperature and one year (2017) rainfall of Assosa, Western Ethiopia

Table 2. Combined mean response of hot pepper varieties for growth, marketable green pod yield and green pod characteristics.

Variety	Days to 50% flowering	days to 50% fruiting	No. of green pods per plant	Pod yield per plant (g)	Single pod weight (g)	Pod length (mm)	Pod diameter (mm)	Marketable green pod yield (t ha ⁻¹)
Jeju	40	76 ^a	133.6 ^a	576.5 ^a	6.2 ^b	74.6 ^a	13.5 ^b	19.47 ^a
Markofana	40	75 ^a	135.4 ^a	608.7 ^a	7.3 ^a	75.4 ^a	15.6 ^a	19.35 ^a
melka awaze	42	75 ^a	109.2 ^b	504.4 ^b	6.1 ^b	77.5 ^a	11.8 ^b	14.66 ^b
Melkashote	42	75 ^a	118.1 ^b	384.6 ^d	4.5 ^d	78.8 ^a	8.3 ^c	14.44 ^b
Bako local	42	72 ^{ab}	142.9 ^a	443.5 ^{bc}	5.0 ^{cd}	74.4 ^a	9.9 ^c	13.97 ^b
Oda haro	43	67 ^b	116.9 ^b	357.3 ^d	5.5 ^{bc}	66.3 ^b	12.7 ^b	13.36 ^b
SEM(+)	0.9	2.4	4.2	23.46	0.24	2.47	0.65	0.638
CV (%)	5.2	7.9	8.2	12	10.2	8.1	13.3	9.8
Level of sig.	ns	*	**	**	**	*	*	**

SEM= standard error of the mean, CV= coefficient of variation ns= non-significant, *=significant, **=highly significant, g=gram, mm= millimeter, t ha⁻¹= ton per hectare. Means in the same columns connected by the same letter are not significantly different at p<0.05.

Table 3. The combined ANOVAs table of effects of deficit irrigation levels on fresh fruit yield and other yield parameters of hot pepper

Treatment	Plant Height (cm)	Marketable yield (t/ha)	Unmarketable yield (t/ha)	Total yield (t/ha)
100% ETc	85.75a	18.14a	2.24a	20.38a
85% of ETc	80.00ab	16.64b	1.84b	18.49b
70% of ETc	76.55bc	14.28c	1.43c	15.71c
50% of ETc	72.43c	11.72d	1.20c	12.92d

of 82 km away from Jinka town, capital of South Omo Zone, Southern Ethiopia. Geographically, the experimental site is located at 5°18'0" to 5°31'33" N latitude and 36°52'30" to 37°5'0" E longitude, and at an altitude of 550 m above sea level. Agro-ecology of study area was arid and semi-arid with mean monthly maximum and minimum temperature of 38°C and 18°C, respectively and average rainfall pattern of 200 -578 mm. Table 3

From the study it was observed that the highest yield was obtained from the treatment grown with no-stress (100% ETc) while the lowest was obtained from half of full irrigation level (50% of ETc). The severe reduction in total yield of 50% ETc was due to the low soil moisture through growth stage. The indicated that, the amount of saved water sharply increased by increasing deficit irrigation levels. That is producing about 63% of total fresh fruit yield led to save 50% of irrigation water, producing about 77% of the total fresh fruit yield saved about 30% of irrigation water, while producing about 90% of total fresh fruit yield led to save 15% of irrigation water.

In general, deficit irrigation could be a feasible irrigation technique for hot pepper production where the benefit from saving large amounts of water. Thus, the result indicates that the appropriate and economically viable way of applying 100% ETc in areas were no water stress required to increased production and productivity of hot pepper. As an option applying 85% ETc of irrigation in water stress areas was optimum means to increase production and productivity of hot pepper without affecting yield [5].

Summery table

As shown in the above table hot pepper give yield from soil PH 5.3-7.83 and from temperature of 28oc-17.85ocwith rain fall of 1316-389mm.the maximum yield22.2q/ha was gained from Assosa agricultural research center at 25oc with annual average rain fall of 1316 .

Generally it is good for producer to grow hot pepper in such agro climatic range to gain high yield hot pepper per hectare.

S.N	Research area	Max temperature in /°c/	Min temperature/in °c/	Average temperature/ in °c/	Annual rain fall / mm/	Soil PH	Mean Yield Q/ha	Citation
1	Gatto Kebele	27	21	24	1200	5.4	16.75	Abrham <i>et.al</i> ,2019
2	Warmit horticultural research center	29.5	6.2	17.85	1250	6.4	20.5	Birhanu .et al,2017
3	Assosa agricultural research center	28	22	25	1316	6	22.2	[3]
4	Humera agricultural research center	37.5	19.85		1200	5.3	19.47	[8]
5	Benna-Tsemay Woreda	38	18	28	389	7.83	20.38	[5]

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