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PERFORMANCE OF COWPEA VARIETIES UNDER MOISTURE STRESS CONDITIONS

ANKITA, NEELAM*, SATPAL, KAUTILYA CHAUDHARY AND PATTAM KEERTHI

Department of Agronomy
CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India
**(e-mail: berkesia.neelam@gmail.com)*

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SUMMARY

A field experiment entitled "Performance of cowpea varieties under moisture stress conditions" was carried out during summer season, 2022 at Research Farm of Forage Section, Department of G & PB, CCS Haryana Agricultural University. The experiment was laid out in split plot design with three replications. It consisted of three irrigation schedules *viz*. irrigation at 7, 11 and 15 days interval and four cowpea varieties *viz*. RC 101, GC 1601, PGCP 24 and HC 46. The texture of the soil was sandy loam with pH 7.9, electrical conductivity (EC) 0.32 dS m^{-1} and organic carbon (OC) 0.46%. The soil was low in available nitrogen (125 kg/ha), medium in phosphorus (13.5 kg/ha) and potassium (290 kg/ha). Irrigation at 15 days interval and variety RC 101 took less number of days to complete almost all physiological stages in crop growth period. Maximum chlorophyll content was recorded under irrigation schedules at 7 days interval, whereas among varieties, highest chlorophyll content at 60 DAS was noted in variety GC 1601, which was at par with chlorophyll content of variety PGCP 24. Highest RWC of cowpea varieties at harvest was recorded with irrigation scheduled at 7 days interval, followed 11 days interval. In varieties significantly maximum RWC was noted in variety RC 101, followed by variety GC 1601, PGCP 24. Maximum corresponding NPK content (3.771 & 1.89%), (0.554 & 0.164%) and (1.39 & 1.70%) in seed and straw, respectively were observed in irrigation schedules of 15 days interval, followed by irrigation schedules at 11 days interval. With more frequent irrigation application, NPK content showed a decreasing trend. Maximum NPK content (3.750 & 1.87 %), (0.547 & 0.160%) and (1.34 & 1.66 %) were observed in seed and straw, respectively in variety GC 1601. Variation in NPK uptake under different irrigation and varieties in both seed and straw was observed due to variation in NPK content.

Key words: Cowpea, varieties, irrigation scheduling, physiological parameters and quality

Cowpea is the only pulse crop suitable to both arid and semi-arid region and can grow in high rainfall regions also, known for its drought-hardy nature with strong tap root system, it has potential to grow quickly in the initial stage suppressing weeds and conserving the soil. This crop also serves as a source of essential nutrients for the human diet and as a means of providing forage for livestock. Nowadays, it is grown in more than 100 countries all over the world. It is also a versatile crop well adapted to a diverse soil and climatic conditions of the humid tropics and sub tropical zones. It is primarily cultivated as a *kharif* and summer season vegetable pulse crop in India. Being short duration, it is best accommodated in the Indian farming system as a main pulse crop, catch crop, cover crop, fodder crop, green manure crop and intercrop under dry land farming as well as irrigated condition.Cowpea is known for its nutritional value forhuman diet as well as for livestock feed and asource of income generation for resource poor farmers (Sheahan, 2012). It is a major source of carbohydrates (63%) and protein (25%) with low fat content (1.5%) and rich invitamin A and C, iron, phosphorus, calciumand amino acids like tryptophan and lysine. The crop has the excellent ability to fix atmospheric nitrogen by root nodules to improve the soil fertility, check soil erosion by deep tap root system and add high amount of organic matter likely to be beneficial for the succeeding crop as well as soil health sustenance (Namakka *et al.*, 2017). In Indian states, it is mostly produced as a minor pulse crop in arid and semi-arid tracts of Rajasthan, Karnataka, Kerala, Tamil Nadu, Maharashtra and Gujarat and in some pockets areas of Punjab, Haryana, Delhi, West Uttar Pradesh and Rajasthan. The crop is mainly grown in summer season under rainfed condition. But due to climatic aberrations there was erratic and uneven distribution of rainfall and the crop suffered several stages of soil moisture stress resulting in low productivity or even crop failure. The other reasons for the poor yield are inhabitation of the crop on marginal and sub-marginal land, inadequate or low fertilizer application and no irrigation at critical growth stages during hot summer months. Among the various factors of production, adequate soil moisture availability can lead to greater yield. The reduction in the availability of water for the plants is mainly caused by the phenomenon of climate change, which is the main obstacle to agricultural crops currently. The crop is susceptible to water stress especially at flowering and pod filling stages and markedly inhibits root hair, nodule growth and biological nitrogen fixation (Aboamera, 2010).Water stress affects the whole process of growth of all organs, metabolism and photosynthesis rate of plant resulting into low production. Selection of proper variety particularly under hot summer season is also a critical factor which may affect the crop yield. Different varieties or genotypes have different yield potential, genetic makeup and morphological traits, which influences their ability to perform under various biotic and abiotic stresses. Some varieties have genes which promote faster growth and higher biomass production while others may have the genes which promote higher uptake of nutrients. Some have resistance toward biotic and abiotic stress i.e. moisture and temperature and can survive efficiently in drought conditions of arid and semi arid areas while, some are better in utilizing the applied nutrient like irrigation and fertilizer and perform superior than others. Although numerous varieties/hybrids and agricultural methods have been created, cowpea productivity has not yet reached the expected level. The yields of conventional farms and those of experimental fields differ significantly. Thus, to achieve high yield per unit area at farmers field, it is important to identify the most effective genotypes for the local ecological circumstances (Carvalho *et al*., 2022). Hence, supplemental irrigation at critical growth stages during hot summer months and suitable varieties are very critical to realize the potential yield. Keeping this in view, the present study was contemplated to plan the irrigation scheduling under summer season to ensure the lowest water supply in order to obtain higher production parameters and productivity.

MATERIALS AND METHODS

The study was carried out at Research area of Forage Section, Department of G&PB, Chaudhary Charan Singh Haryana Agricultural University, Hisar, during summer season of 2022. During the crop growth period, the mean weekly maximum and minimum temperature ranged from 44-27.1°C and 28.6-10.5°C, respectively and total rainfall was 38 mm. The experiment was laid out in split plot design comprised of three irrigation schedules in main plot: I_1: Irrigation at 7 days interval, I_2: Irrigation at 11 days interval, I_3: Irrigation at 15 days interval and four varieties in sub plot: V_1: RC 101, V_2: GC 1601, V_3: PGCP 24, V_4: HC 46. The texture of the soil was sandy loam with pH 7.9, electrical conductivity (EC) 0.32 dS/m and organic carbon (OC) 0.46%. The soil was low in available nitrogen (125 kg/ha), medium in phosphorus (13.5 kg/ha) and potassium (290 kg/ha). The nutrients were applied as per the package and practices i.e. 20 kg N and 40 kg P_2O_5 per ha. Irrigations were applied according to the treatments (7, 11 & 15 day's interval) and varieties were sown at 45 cm row spacing. After harvesting, crop was left in each plot for 4 days for sun drying. The data were analyzed using appropriate analysis of variance (ANOVA). OPSTAT software was used to carry out the statistical analysis.

RESULTS AND DISCUSSION

Phenological studies

Table 1 represented the data pertaining to phenological parameters *viz*. days taken to emergence, days taken to 50% flowering, days taken to 50% pod formation and days taken to physiological maturity. No. of days taken to emergence by cowpea varieties was not affected significantly by different irrigation schedules and varieties. On an average all the treatments took 8.5 days to emerge. This might be due to the fact that a pre sowing irrigation was applied for optimum emergence of cowpea seeds. Maximum no. of days to 50% flowering (46.3 days), 50% pod formation (57.8 days) and physiological maturity (78.5 days) was taken with irrigation scheduling at 7 days interval, followed by irrigation at 11 days interval and 15 days interval, which were at par with each other with corresponding values of (41.8, 50.3 and 73.0 days) & (40.1, 49.3 and 71.1 days). The possible reason for early flowering, pod formation and maturity with irrigation scheduling at 15 days interval was due to less moisture availability to the plant. That's why plant might shorter it's vegetative phase and induce its reproductive phase early to produce seed with

TABLE 1
Effect of irrigation scheduling on growth and physiological parameters of cowpea varieties

Treatments	Days taken to emergence	Days taken to 50% flowering	Days taken to 50% pod formation	Days taken to physiological maturity	Plant height (cm) at harvest	RWC (%) at harvest	Chlorophyll content at 60 DAS
Irrigation schedules							
Irrigation at 7 days interval	8.6	46.3	57.8	78.5	142.08	66.33	63.34
Irrigation at 11 days interval	8.7	41.8	50.3	73.0	126.41	61.85	62.94
Irrigation at 15 days interval	8.5	40.1	49.3	71.1	117.91	59.61	60.73
SE(m)±	0.5	0.6	0.4	0.6	1.84	0.46	0.20
CD (P=0.05)	NS	2.3	1.7	2.4	7.45	1.83	0.78
Varieties							
RC 101	8.9	36.4	46.8	69.1	134.44	65.88	61.83
GC 1601	8.7	44.8	54.6	75.9	129.67	62.85	63.22
PGCP 24	8.7	44.8	54.2	76.0	120.78	61.55	62.33
HC 46	8.2	45.0	54.3	75.8	130.33	60.1	61.95
SE(m)±	0.4	0.6	0.5	0.9	2.07	0.41	0.19
CD (P=0.05)	NS	1.8	1.6	2.6	6.21	1.22	0.57

available resources by the optimum utilization of resources for all stages. In irrigation schedules of 7 days interval surplus moisture favoured luxurious plant growth and plant remained in vegetative phase for longer time and thus took more no. of days to flowering, pod formation and physiological maturity. Among the varieties, RC 101 took the least no. of days to 50% flowering (36.4 days), 50% pod formation (46.8 days) and physiological maturity (69.1 days) as compared to other varieties which were at par with each other. The findings were supported by Singh *et al.* (2014) and Singh and Sekhon (2008).

Growth and Physiological parameters

Perusal of the data in Table 1 also depicted that plant height at harvest of cowpea varieties were significantly affected by irrigation scheduling. Significantly higher values of plant height was recorded by scheduling irrigation at 7 days interval (142.08 cm) at harvest followed by irrigation at 11 days interval with respective values of 126.41 cm. Optimal soil moisture conditions may have encouraged cell enlargement and division, which ultimately led to stem elongation linked with the plant growth and developments in terms of plant height. These findings concur with results reported by Anita and Lakshmi (2015) and Saleh *et al.* (2018). Among varieties, RC 101 recorded significant maximum height (134.44 cm). The difference might be due to genetic makeup of different varieties and their adaptability under different conditions. Similar findings were also observed by Asati *et al.* (2018).

It can be clearly observed from the data that significantly higher value of relative water content at 60 DAS (66.33%) was recorded with irrigation scheduling at 7 days interval. It was followed by irrigation scheduling at 11 days interval. The variation might be due to fact that when irrigations were scheduled more frequently plant absorbed more water and maintained higher moisture content and turgidity while in stress condition due to less moisture availability of soil moisture plant evaporates more water than uptake and moisture available in the leaves reduced as compared to its capacity to hold optimum moisture and due to this relative water content was less in 15 days interval irrigation schedule. Faloye *et al.* (2017) concluded the same results in their research. In varieties significantly maximum relative water content (65.88%) was observed in variety RC 101 at harvest, followed by variety GC 1601 (62.85%), PGCP 24 (61.55%). Variation among the varieties was due to their morphological features, genetic makeup and interaction with environment to cope up with moisture stress. Maximum chlorophyll content of 63.34 at 60 DAS was recorded under irrigation scheduled at 7 days interval, whereas it was at par with chlorophyll content in irrigation scheduling at 11 days interval with value of 62.94. Cowpea has a tendency to decrease its chlorophyll content and alter the orientation of its leaflets in response to drought (drought avoidance mechanism). Saleh *et al.* (2018) and Lata *et al.* (2022) reported similar results. Among varieties, highest chlorophyll content was observed in variety GC 1601 (63.22), which was at par with chlorophyll content of variety PGCP 24. Lata *et al*. (2022) also observed similar results.

Quality parameters

Table 2 shows that Irrigation scheduling had significant effect on N content in both seed and straw. Maximum N content (3.771 & 1.89%) in seed and straw, respectively were observed in irrigation schedules of 15 days interval, followed by irrigation schedules at 11 days interval with respective values of N content (3.726 & 1.85%) in seed and straw. Lowest N content was recorded with irrigation scheduling at 7 days interval with respective N content of (3.704 & 1.82%) and it was at par with irrigation scheduling at 11 days interval for N content in straw.

Varieties also differ in N content. Maximum N content (3.750 & 1.87%) was observed in seed and straw, respectively in variety GC 1601 which was at par with variety PGCP 24 with corresponding N content of (3.747 & 1.86%) in seed and straw. Minimum N content and uptake of (3.713 & 1.83%) were fetched by variety RC 101 with was at par with variety HC 46 with respective N content (3.725 & 1.85%) in seed and straw.

Nitrogen uptake by straw was not affected significantly by irrigation scheduling (Table 3). Maximum N uptake (33.70 kg/ha) in seed & (35.12 kg/ha) in straw, respectively were observed in irrigation schedules of 11 and 7 days interval, followed by uptake (32.95 kg/ha) in seed & (32.39 kg/ha) in straw with irrigation at 15 and 11 days, respectively. Lowest N uptake was recorded with irrigation scheduling at 7 days interval in seed and with 15 days interval in straw with respective values of 24.45 kg/ha and 32.25 kg/ha. Varieties also differ in N uptake. Maximum N uptake in seed was recorded in variety GC 1601 which was at par with variety PGCP 24 with corresponding uptake of (35.16 & 33.76 kg/ha). Minimum N uptake of seed was recorded in variety HC 46 which was at par with variety RC 101 with respective values of (25.45 and 27.11 kg/ha). Significantly maximum N uptake of 37.40 kg/ha in straw was observed in variety RC 101, followed by GC 1601 and HC 46 with N uptake of 34.73 and 31.53 kg/ha, respectively. Minimum N uptake of 29.35 kg/ha in straw was recorded in variety PGCP 24 which was at par with HC 46. Ankita *et al*. (2023) also reported that irrigation at 15 days interval and GC 1601 variety were superior in terms of quality.

Irrigation scheduling had significant effect on P content in both seed and straw (Table 2). Maximum P content (0.554 & 0.164%) in seed and straw, respectively were observed in irrigation schedules of 15 days interval, followed by irrigation schedules at 11 days interval with respective values of P content (0.531 & 0.160%) in seed and straw, it was at par with irrigation scheduling at 15 days interval for P content in straw. Lowest P content was recorded with irrigation scheduling at 7 days interval with respective P content of (0.516 & 0.144%). Varieties also differ in P content. Maximum P content (0.547 & 0.160%) were observed in seed and straw, respectively in variety GC 1601 which was at par with variety PGCP 24 with corresponding P content of (0.545 & 0.159%) in seed and straw. Minimum P content of (0.519 &

TABLE 2

Effect of irrigation scheduling on N, P and K content (%) in seed and straw of cowpea

Treatments	Nitrogen content (%)		Phosphorous content (%)		Potassium content (%)	
	Seed	Straw	Seed	Straw	Seed	Straw
Irrigation schedules						
Irrigation at 7 days interval	3.704	1.82	0.516	0.144	1.19	1.55
Irrigation at 11 days interval	3.726	1.85	0.531	0.160	1.30	1.60
Irrigation at 15 days interval	3.771	1.89	0.554	0.164	1.39	1.70
SE(m)±	0.003	0.01	0.001	0.001	0.01	0.01
CD (P=0.05)	0.012	0.04	0.001	0.005	0.03	0.03
Varieties						
RC 101	3.713	1.83	0.519	0.150	1.25	1.57
GC 1601	3.750	1.87	0.547	0.160	1.33	1.66
PGCP 24	3.747	1.86	0.545	0.159	1.34	1.66
HC 46	3.725	1.85	0.523	0.154	1.25	1.56
SE(m)±	0.004	0.01	0.002	0.001	0.01	0.03
CD (P=0.05)	0.011	0.03	0.005	0.003	0.02	0.09

0.150%) were found in variety RC 101 which was at par with variety HC 46 in terms of P content with respective P content (0.523 & 0.154%) in seed and straw.

Irrigation scheduling did not have any significant effect on P uptake in straw (Table 3). Maximum P uptake (4.84 & 2.80 kg/ha) in seed and straw, respectively were observed in irrigation schedules of 15 days interval, followed by irrigation schedules at 11 days interval with respective values of P uptake (4.81 & 2.79 kg/ha) in seed and straw. Lowest P uptake was recorded with irrigation scheduling at 7 days interval in seed and straw with respective values of 3.42 kg/ha and 2.79 kg/ha. Varieties also differ in P uptake. Maximum P uptake in seed was recorded in variety GC 1601 which was at par with variety PGCP 24 with corresponding uptake of (5.14 & 4.91 kg/ha). Minimum P uptake of seed was recorded in variety HC 46 which was at par with variety RC 101 with respective values of (3.59 and 3.80 kg/ha). Significantly maximum P uptake of 3.09 kg/ha in straw was recorded in variety RC 101 which was at par with GC 1601 with uptake of 2.95 kg/ha, followed by HC 46 with P uptake of 2.63 kg/ha. Minimum P uptake of 2.50 kg/ha in straw was recorded in variety PGCP 24 which was at par with HC 46.

Irrigation scheduling had significant effect on K content in both seed and straw (Table 2). Maximum content (1.39 & 1.70%) in seed and straw, respectively was observed in irrigation schedules of 15 days interval, followed by irrigation schedules at 11 days interval with respective values of K content (1.30 & 1.60%) in seed and straw. Lowest K content was recorded with irrigation scheduling at 7 days interval with respective K content of (1.19 & 1.55%). Among varieties, maximum K content (1.34 & 1.66 %) was observed in seed and straw, respectively in variety PGCP 24 which was at par with variety GC 1601 with corresponding K content of (1.33 & 1.66%) in seed and straw. Minimum K content of (1.25& 1.56%) was observed in variety HC 46 with was at par with variety RC 101 with respective K content (1.25 & 1.56%) in seed and straw.

Maximum K uptake (12.17 kg/ha) in seed & (30.06 kg/ha) in straw, respectively were observed in irrigation schedules of 15 and 7 days interval, followed by irrigation schedules at 11 days interval with respective values of K uptake (11.78 & 28.89 kg/ha) in seed and straw (Table 3). Lowest K uptake was recorded with irrigation scheduling at 7 days interval in seed and with 15 days interval in straw with respective values of 7.90 kg/ha and 27.98 kg/ha. Among varieties, maximum K uptake in seed was recorded in variety GC 1601 which was at par with variety PGCP 24 with corresponding uptake of (12.54 & 12.12 kg/ha). The minimum uptake of seed was recorded in variety HC 46 which was at par with variety RC 101 with respective values of (8.61 & 9.18 kg/ha). Maximum K uptake of 32.22 kg/ha in straw was found in variety RC 101, followed by GC 1601 and HC 46 with K uptake of (30.68 and 26.99 kg/ha), respectively. Minimum K uptake of 26.02 kg/ha in straw was recorded in variety PGCP 24 which was at par with HC 46. With more frequent irrigation application NPK content showed a decreasing trend. It might be due to dilution effect of nutrient because

TABLE 3

Effect of irrigation scheduling on N, P and K uptake (kg/ha) in seed and straw of cowpea

Treatments	Nitrogen uptake (kg/ha)		Phosphorus uptake (kg/ha)		Potassium uptake (kg/ha)	
	Seed	Straw	Seed	Straw	Seed	Straw
Irrigation schedules						
Irrigation at 7 days interval	24.45	35.12	3.42	2.79	7.90	30.07
Irrigation at 11 days interval	33.70	32.39	4.81	2.79	11.78	28.89
Irrigation at 15 days interval	32.95	32.25	4.84	2.80	12.17	27.98
SE(m)±	0.52	0.65	0.08	0.069	0.17	0.67
CD (P=0.05)	2.11	NS	0.30	NS	0.68	0.62
Varieties						
RC 101	27.11	37.40	3.80	3.09	9.18	32.22
GC 1601	35.16	34.73	5.14	2.95	12.54	30.68
PGCP 24	33.76	29.35	4.91	2.50	12.12	26.02
HC 46	25.45	31.53	3.59	2.63	8.61	26.99
SE(m)±	0.65	0.73	0.09	0.69	0.23	0.68
CD (P=0.05)	1.94	2.18	0.29	0.21	0.69	2.04

of higher biomass production under frequent irrigation. NPK content in varieties also differ due to their yield potential and resource use efficiency. Variation in NPK uptake under different irrigation and varieties in both seed and straw was due to variation in NPK content and yield as it depends on NPK content and yield of particular irrigation schedule and variety, which were different for each irrigation schedule and variety.

CONCLUSION

It was concluded that, irrigation at 15 days interval and variety RC 101 took less number of days to complete almost all physiological stages in crop growth period. Maximum RWC (at harvest) and chlorophyll content at 60 DAS were recorded under irrigation schedules at 7 days interval but the later one was at par with 11 days irrigation interval. In varieties significantly maximum relative water content and chlorophyll content was noted in variety RC 101 and GC 1601, respectively. Maximum NPK content in seed and straw were observed in irrigation schedules of 15 days interval, followed by irrigation schedules at 11 days interval. In case of varieties, maximum NPK content were observed in seed and straw in variety GC 1601.

REFERENCES

Aboamera, M.A., 2010 : Response of cowpea to water deficit under semi-portable sprinkler irrigation system. *Misr Journal of Agricultural Engineering*, **27**(1): 170-190.

Ankita, Neelam, Satpal and Anil Kumar, 2023 : Evaluation of cowpea varieties under different irrigation schedules. *Forage Res*., **49**(3): 310-314.

Anita, M.R. and M. Lakshmi, 2015: Growth characters of fodder cowpea varieties as influenced by soil moisture stress levels. *Indian Journal of Agricultural Res.*, **49**(5): 464-467.

Asati, K.P., P. Makwane and S. Barche, 2018 : Performance of different genotypes of cowpea (*Vigna unguiculata* (L.) Walp.) in Malwa Plateau of Madhya Pradesh. *International Journal of Current Microbiology and Applied Sciences*, **7**(2): 3585-3588.

Carvalho, M., V. Carnide, C. Sobreira, I. Castro, J. Coutinho, A. Barros and E. Rosa, 2022 : Cowpea Immature Pods and Grains Evaluation: An Opportunity for Different Food Sources. *Plants*, **11**(16): 2079.

Faloye, O.T. and M.O. Alatise, 2017 : Response of soil moisture content, evapotranspiration and yield of cowpea to varying water application. *Agricultural Engineering International: CIGR Journal*, **19**(4): 66-75.

Lata, K., P.K. Yadav, R.S. Rathore and N.K. Pareek, 2022 : Effect of irrigation regimes on quality parameters of Cowpea (*Vigna unguiculata* L. Walp.). *The Pharms Innovation*, **11**(8): 2145-2147.

Namakka A., D.M. Jibrin, I.L. Hamma and J. Bulus, 2017 : Effect of phosphorus levels on growth and yield of cowpea (*Vigna unguiculata* (L.) Walp) in Zaria, Nigeria. *Journal of Dryland Agriculture*, **3**(1): 85-93.

Saleh, S., G. Liu, M. Liu, Y. Ji, H. He and N. Gruda, 2018: Effect of irrigation on growth, yield and chemical composition of two bean cultivars. *Horticulturae*, **4**(3).

Sheahan, C.M., 2012 : Plant guide for cowpea (*Vigna unguiculata* (L.) Walp). *USDA Natural Resources Conservation Services*, Cape May, Plant Materials Center, Cape May, NJ.

Singh, A.K., A. Jaiswal, A. Singh, P.K. Upadhyay and S.K. Choudhary, 2014 : Effect of irrigations and phosphorus fertilization on productivity, water use efficiency, and soil health of summer mungbean (*Vigna radiata* L.). *The Ecoscan*, **8**(1&2): 185-191.

Singh, G. and H.S. Sekhon, 2008 : Effect of various inputs on the growth and yield of summer greengram (*Vigna radiata*). *Indian Journal of Agricultural Sciences*, **78**(1): 87-89.