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Effect of antitranspirants on growth and productivity of chickpea genotypes

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Abstract
To study the effect of antitranspirants on growth and productivity of chickpea genotypes under rainfed and irrigated conditions, the experiment was taken during *rabi* season of 2021-22 and 2022-23 at MARS, Dharwad, Karnataka. The experiment was laid out in split-split plot design by taking two irrigation levels in main plot (I_1- Rainfed, I_2- Irrigation at pre flowering stage), three chickpea genotypes in sub plot (G_1- BGD111-1, G_2- DBGV-204, G_3- Super Annigeri) and three antitranspirants in sub-sub plot (A_1- No antitranspirant spray, A_2- Kaolin spray (5%), A_3- Atrazin spray (0.01%) at pre flowering and pod formation stage) with three replications. The pooled data of the experiment showed significant increase in plant height, number of branches, leaf area, leaf area index, number of pods plant^{-1}, test weight and seed yield with application of irrigation at pre flowering stage compared to rainfed condition. Among the genotypes, Super Annigeri recorded significantly higher number of branches and pods plant^{-1}. However, BGD 111-1 recorded significantly higher total dry matter production (29.97 g plant^{-1}) and seed yield of 1763 kg ha^{-1}. Among the antitranspirants, spraying of Kaolin (5%) at pre flowering and pod formation stage recorded significantly higher number of pods plant^{-1} (51.1), test weight (21.90 g) and seed yield (1798 kg ha^{-1}) along with higher growth parameters. However, Atrazin spray (0.01%) at pre flowering and pod formation stage recorded lower values.

Keywords: Atrazin, BGD 111-1, kaolin, seed yield

Introduction
Chickpea (*Cicer arietinum* L.) is an important *rabi* pulse crop grown all over the world and it plays an important role in sustaining soil productivity by improving its physical, chemical and biological properties and trapping atmospheric nitrogen in their root nodules. In world, it is cultivating in an area of 14.84 m ha, production of 15.08 m t and productivity of 1016 kg ha^{-1}. India contributes to about 72 per cent of area and 71 per cent production of total chickpea in the world by occupying an area of 11.49 m ha, production of 10.74 m t and productivity of 1086 kg ha^{-1}. In Karnataka the crop occupied an area of 1.10 m ha with a production of 0.61 m t and productivity of 617 kg ha^{-1} (Anon., 2021) [4]. Despite the high yield potential of chickpea, the actual yields are significantly lower due to a combination of biotic and abiotic stresses. Chickpea is generally grown under rainfed conditions on stored soil moisture, as chickpea is susceptible to several major biotic and abiotic stresses often leading to decline in the yields. Hence, it is necessary to take measures for yield maximization of chickpea which includes, irrigation at critical stages, selection of suitable genotypes and by maintaining the plant water balance using antitranspirants. Under rain fed condition the chickpea crop usually faces moisture stress due to low rainfall and responds favorably to supplemental irrigation hence, scheduling of irrigation at critical growth stages assumes greater significance. It is clear that high yielding and suitable genotypes with good adoptability in hand, higher production can be expected with efficient use of available water. It is recognized that drought tolerant genotypes under water stress conditions develops various physiological and biochemical responses of adaptive nature. The effect of shortage of water can be compensated by conserving the available water in plant body by the use of antitranspirants. Antitranspirants are white materials which form a coating on the leaves and increase the leaf reflectance (albedo). By reflecting the radiation, they reduce leaf temperatures and vapor pressure gradient from leaf to atmosphere and thus reduce transpiration. Successful antitranspirant use, involves achieving a favorable balance of restricting moisture loss from leaves without restricting photosynthesis. Hence, the present study was undertaken with the objective to investigate growth and yield of chickpea genotypes as influenced by antitranspirants under rainfed and irrigated conditions.

Materials and Methods

The experiment was conducted during *rabi* season of 2021-22 and 2022-23 at main agricultural research station, Dharwad, Karnataka. The soil of the experimental field was clay loam in texture with pH of 7.87. The soil was low in available nitrogen (235.90 kg ha^{-1}), medium in available phosphorus (23.80 kg ha^{-1}) and high in available potassium (385.10 kg ha^{-1}). The experiment was laid out in split-split plot design with two irrigation levels as main plot (I_1- Rainfed, I_2- Irrigation at pre flowering stage), three chickpea genotypes as sub plot (G_1- BGD111-1, G_2- DBGV-204, G_3- Super Annigeri) and three antitranspirants as sub-sub plot (A_1- No antitranspirant (control), A_2- Kaolin (5%), A_3- Atrazin (0.01%) at pre flowering and pod formation stage) with three replications. Chickpea was sown with 30 cm row to row spacing and 10 cm plant to plant with basal application of 10: 25: 0 and 25: 50: 0 kg ha^{-1}, N, P_2O_5 and K_2O for rainfed and irrigated conditions, respectively.

Results and Discussion

Pooled data of the experiment showed that, among the irrigation regimes significant difference was observed with respect to growth and yield of chickpea. Scheduling of irrigation at pre flowering stage recorded significantly higher plant height (40.71 cm), number of primary branches $plant^{-1}$ (3.73), number of secondary and tertiary branches $plant^{-1}$ (19.76), leaf area (3.43 dm^2 $plant^{-1}$), leaf area index (1.14), total dry matter production (30.42 g $plant^{-1}$), number of pods $plant^{-1}$ (47.9), test weight (21.92 g) and seed yield (1754 kg ha^{-1}) compared to the rainfed condition (Fig. 1a). The overall development in growth and yield attributes of chickpea in association with irrigation level was due to the moisture availability in the root zone which increased the nutrient uptake and produces multiple physiological effects *viz*., increase in photosynthetic efficiency and net assimilation which results in the increased plant growth. It was followed by translocation of photosynthates towards the sink and resulted in the higher number of pods $plant^{-1}$, test weight and seed yield (Table 1, 2 and 3). These results also confirms with findings of Singh *et al*. (2017) [9] where scheduling of irrigation at pod development stage increased the seed yield by 28.94 per cent compared to no irrigation level. Similar results were observed by Raghavendra *et al*. (2017) [7] and Swetha and Hussain (2017) [10]. Lower growth and yield in the rainfed condition was due to reduced photosynthetic rate which impede the growth. It could be concluded that decreased water availability under drought results in reduced photosynthetic rate and less assimilate production for growth of plants (Ahmed *et al*., 2013) [2].

Among the genotypes, significantly higher plant height (43.21 cm), leaf area (3.49 dm^2 $plant^{-1}$), leaf area index (1.16) were recorded in the genotype DBGV 204 compared to other genotypes. The genotype Super Annigeri recorded significantly higher number of primary (3.79) and number of secondary and tertiary branches $plant^{-1}$ (18.97) and number of pods $plant^{-1}$ (48.3). Significantly higher total dry matter production (29.97), test weight (23.26 g) and seed yield (1763 kg ha^{-1}) were recorded in the BGD 111-1 (Fig. 1a). However, lower seed yield was recorded in the Super Annigeri and it was found on par with DBGV 204 (Table 3). The variation in the result was mainly due to inherent genetic potentiality of the genotypes. Inherent characteristic of particular genotypes plays a vital role on growth and development of crop, which might be responsible for higher seed yield. Even though, genotype Super Annigeri recorded higher number of pods $plant^{-1}$, it recorded lower seed yield because of its smaller seed size and lower test weight (17.81 g). Whereas, higher yield in the BGD 111-1 was due to moderate number of pods and higher test weight (Table 1 and 2). These results of varietal differences in growth parameters are in agreement with those obtained by (Akay, 2011 and El-Habbasha *et al*., 2012) [3, 5]. Similarly, in the study of Mansourifar *et al.* (2020) [12], genotype ILC 482 recorded higher number of pods (26.9) and Hashem recorded higher grains $plant^{-1}$ (1.19). Whereas, significantly higher test weight and grain yield were obtained by Bivanij cultivar (31.6 g and 1675.5 kg ha^{-1}) as result of genotypic variation.

Among the antitranspirants significant difference was observed with respect to growth and yield of the chickpea. Kaolin (5%) spray at pre flowering and pod formation stage recorded significantly higher plant height (42.21 cm), number of primary branches $plant^{-1}$ (3.91), number of secondary and tertiary branches $plant^{-1}$ (19.39), leaf area (3.45 dm^2 $plant^{-1}$), leaf area index (1.15), total dry matter production (32.64 g $plant^{-1}$), number of pods $plant^{-1}$ (51.1), test weight (21.90 g), along with 10.71 and 13.51 per cent higher seed yield compared to control and atrazin (0.01%) spray, respectively (Fig. 1a, Table 1, 2 and 3). Foliar spray with kaolin reduced the transpiration rate, which in turn maintained higher water content in plant tissues, possibly favoring plant metabolism, physiological processes, photosynthetic rate, carbohydrate metabolism and many other important functions which directly affect plant growth (Ibrahim and Selim, 2010) [6]. Segura-Monroy *et al*. (2015) [8] observed increase in plant height and plant dry weight of *Physalis peruviana* L. seedlings with application of kaolin. Further, increase in the seed yield was due to reduced water loss through transpiration which in turn increased the leaf resistance to water vapor loss and improved plant water usage in assimilation of carbon and production of biomass or yield (Tambussi and Bort, 2007) [11]. In this respect, Adolfo (2007) [1] reported improved plant physiological activities under hot weather and water stress conditions with kaolin application. Lower seed yield in the atrazin (0.01%) spray was due to phytotoxic effect of the atrazin on crop which reduced the photosynthesis, growth and yield.

Among the interactions, genotype BGD 111-1 with application of kaolin (5%) at pre flowering and pod formation stage and scheduling of irrigation at pre flowering stage recorded significantly higher growth and yield attributes along with 39.68 per cent higher seed yield compared to treatment with atrazin (0.01) spray in Super Annigeri under rainfed condition (Fig. 1b and Table 3).

Table 1: Number of pods plant^{-1} in chickpea genotypes as influenced by antitranspirants under rainfed and irrigated conditions

Number of pods plant^{-1}													
Treatment		**2021**				**2022**				**Pooled**			
		Antitranspirants				**Antitranspirants**				**Antitranspirants**			
Irrigation	**Genotypes**	**A$_1$**	**A$_2$**	**A$_3$**	**Mean**	**A$_1$**	**A$_2$**	**A$_3$**	**Mean**	**A$_1$**	**A$_2$**	**A$_3$**	**Mean**
I$_1$	G$_1$	30.1^{gh}	40.5^{de}	27.3^{g-i}	32.6^{d}	32.2^{gh}	44.5^{c-f}	29.8^{hi}	35.5^{d}	31.2^{ij}	42.5^{ef}	28.5^{j}	34.1^{d}
	G$_2$	25.1^{hi}	35.9^{d-f}	22.3^{i}	27.8^{e}	26.2^{i}	36.5^{e-h}	24.0^{i}	28.9^{e}	25.6^{k}	36.2^{f-i}	23.2^{k}	28.3^{e}
	G$_3$	37.5^{d-f}	47.8^{c}	34.4^{e-g}	39.9^{c}	37.8^{c-g}	51.3^{cd}	35.4^{f-h}	41.5^{c}	37.7^{e-g}	49.5^{cd}	34.9^{g-j}	40.7^{c}
	Mean	30.9^{d}	41.4^{c}	28.0^{d}	33.4^{b}	32.1^{d}	44.1^{c}	29.7^{d}	35.3^{b}	31.5^{d}	42.7^{c}	28.9^{d}	34.4^{b}
I$_2$	G$_1$	41.7^{d}	56.7^{b}	37.6^{d-f}	45.3^{b}	45.1^{c-e}	62.0^{b}	39.9^{d-h}	49.0^{b}	43.4^{de}	59.3^{b}	38.8^{f-h}	47.2^{b}
	G$_2$	35.d-f	50.6^{c}	32.0^{fg}	39.5^{c}	38.5^{d-h}	52.1^{c}	34.9^{gh}	41.8^{c}	37.2^{e-h}	51.3^{c}	33.5^{h-j}	40.7^{c}
	G$_3$	51.5^{b}	66.1^{a}	47.4^{c}	55.0^{a}	52.3^{b}	69.5^{a}	48.4^{c}	56.8^{a}	51.9^{b}	67.8^{a}	47.9^{e}	55.9^{a}
	Mean	43.0^{b}	57.8^{a}	39.0^{c}	46.6^{a}	45.3^{b}	61.2^{a}	41.1^{c}	49.2^{a}	44.2^{b}	59.5^{a}	40.0^{c}	47.9^{a}
Mean of G$_1$		35.9^{e}	48.6^{b}	32.4^{ef}	39.0^{b}	38.6^{cd}	53.3^{b}	34.9^{de}	42.3^{b}	37.3^{d}	50.9^{b}	33.7^{e}	40.6^{b}
Mean of G$_2$		30.5^{fg}	43.2^{cd}	27.2^{g}	33.6^{a}	32.4^{ef}	44.3^{c}	29.5^{f}	35.4^{c}	31.4^{ef}	43.8^{c}	28.3^{f}	34.5^{c}
Mean of G$_3$		44.5^{bc}	57.0^{a}	40.9^{d}	47.5^{c}	45.1^{b}	60.4^{a}	41.9^{c}	49.1^{a}	44.8^{b}	58.7^{a}	41.4^{c}	48.3^{a}
Mean (A)		37.0^{b}	49.6^{a}	33.5^{c}		38.7^{b}	52.6^{a}	35.4^{c}		37.8^{b}	51.1^{a}	34.5^{c}	
Sources		S.Em±				S.Em±				S.Em±			
Irrigation (I)		1.0				1.0				0.8			
Genotypes (G)		1.0				1.0				0.8			
Antitranspirants (A)		0.8				0.9				0.6			
I×G		1.3				1.3				1.1			
I×A		1.2				1.3				0.8			
G×A		1.4				1.6				1.0			
I×G×A		2.1				2.3				1.4			

Irrigation (I)
I$_1$- Rainfed
I$_2$- Irrigation at pre flowering stage

Genotypes (G)
G$_1$-BGD 111-1
G$_2$-DBGV 204
G$_3$-Super Annigeri

Antitranspirants (A)
A$_1$-No antitranspirant spray (Control)
A$_2$- Kaolin spray (5%) at pre flowering and pod formation stage
A$_3$- Atrazine spray (0.01%) at pre flowering and pod formation stage

Table 2: Test weight of chickpea genotypes as influenced by antitranspirants under rainfed and irrigated conditions

Test weight (g)													
Treatment		**2021**				**2022**				**Pooled**			
		Antitranspirants				**Antitranspirants**				**Antitranspirants**			
Irrigation	**Genotypes**	**A$_1$**	**A$_2$**	**A$_3$**	**Mean**	**A$_1$**	**A$_2$**	**A$_3$**	**Mean**	**A$_1$**	**A$_2$**	**A$_3$**	**Mean**
I$_1$	G$_1$	22.28^{c-g}	22.64^{b-f}	22.17^{e-g}	22.36^{b}	22.90^{b-d}	23.43^{a-c}	21.66^{cd}	22.66^{bc}	22.75^{c-e}	23.23^{b-d}	21.87^{e}	22.62^{b}
	G$_2$	21.75^{fg}	22.25^{d-g}	21.37^{g}	21.79^{c}	22.49^{b-d}	22.90^{b-d}	21.80^{d}	22.40^{c}	22.31^{de}	22.74^{c-e}	21.69^{e}	22.24^{b}
	G$_3$	17.19^{i}	17.95^{hi}	17.09^{i}	17.41^{e}	17.28^{fg}	17.71^{e-g}	16.70^{g}	17.23^{e}	17.26^{h}	17.77^{f-h}	16.80^{h}	17.28^{d}
	Mean	20.41^{de}	20.88^{cd}	20.21^{e}	20.52^{b}	20.89^{bc}	21.34^{b}	20.06^{c}	20.76^{b}	20.77^{cd}	21.24^{c}	20.12^{d}	20.71^{b}
I$_2$	G$_1$	23.38^{ab}	23.85^{a}	23.20^{a-c}	23.48^{a}	24.06^{ab}	25.35^{a}	23.24^{b-d}	24.21^{a}	23.76^{a-c}	24.77^{a}	23.19^{b-d}	23.91^{a}
	G$_2$	23.14^{a-d}	23.52^{ab}	22.77^{b-e}	23.14^{b}	23.64^{a-d}	24.54^{ab}	23.32^{b-d}	23.84^{b}	23.39^{b-d}	24.08^{ab}	23.06^{b-d}	23.51^{a}
	G$_3$	18.12^{hi}	17.43^{h}	17.85^{hi}	18.13^{bc}	18.79^{ef}	19.03^{e}	17.73^{e-g}	18.52^{d}	18.50^{fg}	18.84^{f}	17.72^{gh}	18.35^{c}
	Mean	21.38^{ab}	21.77^{a}	21.11^{bc}	21.58^{a}	21.16^{ab}	22.97^{a}	21.43^{b}	22.19^{a}	21.88^{b}	22.56^{a}	21.32^{bc}	21.92^{a}
Mean of G$_1$		22.83^{ab}	23.25^{a}	22.69^{a-c}	22.92^{a}	23.48^{a-c}	24.39^{a}	22.45^{bc}	23.44^{a}	23.25^{a-c}	24.00^{a}	22.53^{cd}	23.26^{a}
Mean of G$_2$		22.45^{bc}	22.89^{ab}	22.07^{c}	22.47^{a}	23.07^{bc}	23.72^{ab}	22.56^{c}	23.12^{b}	22.85^{b-d}	23.41^{ab}	22.37^{d}	22.88^{ab}
Mean of G$_3$		17.66^{de}	18.19^{d}	17.47^{e}	17.77^{d}	18.03^{de}	18.37^{d}	17.22^{e}	17.87^{c}	17.88^{ef}	18.30^{e}	17.26^{f}	17.81^{b}
Mean (A)		20.98^{b}	21.44^{a}	20.74^{c}		21.53^{b}	22.16^{a}	20.74^{c}		21.33^{b}	21.90^{a}	20.72^{c}	
Sources		S.Em±				S.Em±				S.Em±			
Irrigation (I)		0.23				0.25				0.15			
Genotypes (G)		0.23				0.25				0.13			
Antitranspirants (A)		0.22				0.23				0.14			
I×G		0.32				0.35				0.18			
I×A		0.31				0.33				0.20			
G×A		0.38				0.40				0.25			
I×G×A		0.53				0.57				0.35			

Irrigation (I)
I$_1$- Rainfed
I$_2$- Irrigation at pre flowering stage

Genotypes (G)
G$_1$-BGD 111-1
G$_2$-DBGV 204
G$_3$-Super Annigeri

Antitranspirants (A)
A$_1$-No antitranspirant spray (Control)
A$_2$- Kaolin spray (5%) at pre flowering and pod formation stage
A$_3$- Atrazine spray (0.01%) at pre flowering and pod formation stage

Table 3: Seed yield of chickpea genotypes as influenced by antitranspirants under rainfed and irrigated conditions

Seed yield (kg ha^{-1})													
Treatment		**2021**				**2022**				**Pooled**			
		Antitranspirants				**Antitranspirants**				**Antitranspirants**			
Irrigation	**Genotypes**	**A$_1$**	**A$_2$**	**A$_3$**	**Mean**	**A$_1$**	**A$_2$**	**A$_3$**	**Mean**	**A$_1$**	**A$_2$**	**A$_3$**	**Mean**
I$_1$	G$_1$	1564^{d-f}	1730^{b-d}	1551^{d-f}	1615^{b-d}	1656^{e-g}	1821^{b-d}	1631^{e-h}	1702^{b}	1610^{f-i}	1776^{b-e}	1591^{f-i}	1659^{b}
	G$_2$	1499^{ef}	1658^{b-e}	1476^{ef}	1545^{cd}	1565^{f-i}	1737^{c-e}	1512^{g-i}	1605^{bc}	1532^{g-j}	1697^{c-f}	1494^{h-j}	1575^{c}
	G$_3$	1470^{ef}	1625^{c-f}	1423^{f}	1506^{d}	1497^{hi}	1637^{e-h}	1454^{i}	1529^{c}	1483^{ij}	1631^{f-i}	1439^{j}	1517^{c}
	Mean	1511^{c}	1671^{b}	1484^{c}	1555^{b}	1573^{c}	1731^{b}	1532^{c}	1612^{b}	1542^{c}	1701^{b}	1508^{c}	1584^{b}
I$_2$	G$_1$	1765^{a-c}	1961^{a}	1746^{a-d}	1824^{a}	1861^{bc}	2059^{a}	1808^{b-d}	1909^{a}	1813^{bc}	2010^{a}	1777^{b-d}	1867^{a}
	G$_2$	1637^{b-e}	1834^{ab}	1599^{c-f}	1690^{b}	1707^{d-f}	1906^{b}	1650^{e-g}	1754^{b}	1672^{d-f}	1870^{b}	1625^{f-h}	1722^{b}
	G$_3$	1621^{b-f}	1809^{a-c}	1566^{d-f}	1665^{bc}	1650^{e-g}	1801^{b-d}	1597^{e-i}	1683^{bc}	1636^{e-g}	1805^{b-d}	1582^{f-j}	1674^{b}
	Mean	1674^{b}	1868^{a}	1637^{b}	1726^{a}	1739^{b}	1922^{a}	1685^{b}	1782^{a}	1707^{b}	1895^{a}	1661^{b}	1754^{a}
Mean of G$_1$		1665^{b-d}	1846^{a}	1649^{b-d}	1720^{a}	1759^{bc}	1940^{a}	1719^{cd}	1806^{a}	1712^{b}	1893^{a}	1684^{bc}	1763^{a}
Mean of G$_2$		1568^{c-e}	1746^{ab}	1538de	1617^{b}	1636de	1821^{b}	1581ef	1679^{b}	1602^{cd}	1784^{b}	1559^{d}	1648^{b}
Mean of G$_3$		1545de	1717^{bc}	1495^{e}	1586^{b}	1574^{ef}	1719^{cd}	1526^{f}	1606^{b}	1559^{d}	1718^{b}	1510^{d}	1596^{bc}
Mean (A)		1593^{b}	1769^{a}	1560^{b}		1656^{b}	1827^{a}	1609^{b}		1624^{b}	1798^{a}	1584^{b}	
Sources		S.Em±				S.Em±				S.Em±			
Irrigation (I)		26				28				26			
Genotypes (G)		26				27				14			
Antitranspirants (A)		24				20				17			
I×G		36				39				20			
I×A		34				29				24			
G×A		41				36				29			
I×G×A		58				50				42			

Irrigation (I)
I$_1$- Rainfed
I$_2$- Irrigation at pre flowering stage

Genotypes (G)
G$_1$-BGD 111-1
G$_2$-DBGV 204
G$_3$-Super Annigeri

Antitranspirants (A)
A$_1$-No antitranspirant spray (Control)
A$_2$- Kaolin spray (5%) at pre flowering and pod formation stage
A$_3$- Atrazine spray (0.01%) at pre flowering and pod formation stage

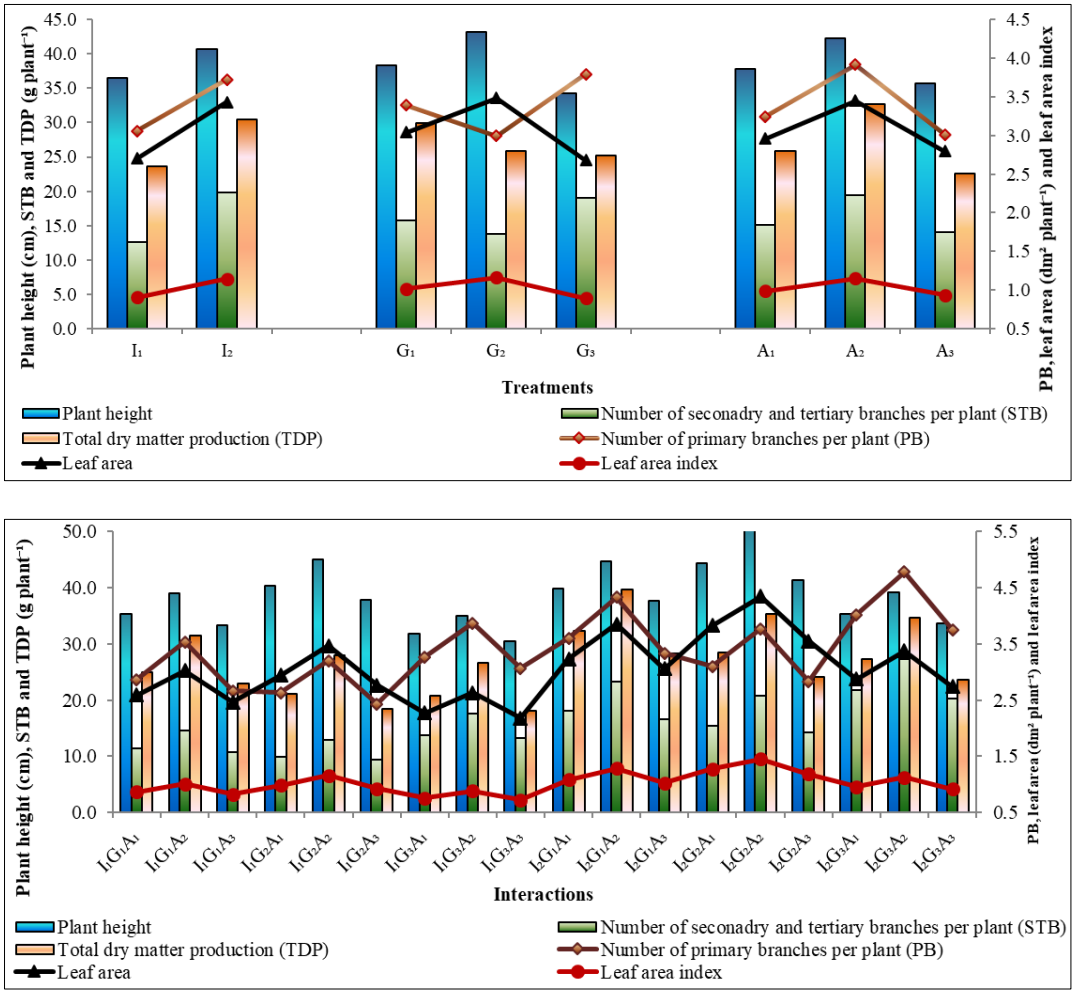

Fig 1: Growth parameters of chickpea genotypes as influenced by antitranspirants under rainfed and irrigated conditions

Summary and Conclusion

Thus it can be concluded that, kaolin (5%) spray in the genotype BGD 111-1 at pre flowering and pod formation stage is the good option for achieving higher yield under both rainfed and irrigated condition.

References

1. Adolfo R, Physiological effects of kaolin particle film technology. Functional plant Science and Biotechnology. 2007;1(1):100-105.
2. Ahmed AG, Zaki NM, Magda H, Mohamed MM, Tawfik, Hassanein MS. Growth and Yield Response of Two Chickpea Cultivars (*Cicer arietinum* L.) to Skipping One Irrigation. Middle East Journal of Agriculture Research. 2013;2(4):146-151.
3. Akay A. Effect of zinc fertilizer applications on yield and element contents of some registered chickpeas cultivars. African Journal of Biotechnology. 2011;10(60):12890-12896.
4. Anonymous. Annual report, Ministry of Agriculture and Farmers Welfare, Directorate of pulses development, Vindhyachal Bhavan, Bhopal; c2021.
5. El-Habbasha SF, Ahmed AG, Mohamed MH. Response of some chickpea cultivars to compound foliar fertilizer under sandy soil conditions. Journal of Applied Sciences Research. 2012;8(10):5177-5183.
6. Ibrahim A, Seilm EM. Effect of irrigation intervals and transpirants (Kaolin) on summer squash (*Curbit apeoo* L.) growth, yield quality and economies. Journal of Soil Science and agricultural Engineering. 2010;1:883-894.
7. Raghavendra T, Jayalakshmi V, Jaffar Basha S. Physiological characters and yield of chickpea (*Cicer arietinum* L.) as influenced by dates of sowing, varieties and irrigation regimes in vertisols of scarce rainfall zone of Andhra Pradesh. Bulletin on Environment Pharmacology Life Science. 2017;6(3):81-83.
8. Segura-Monroy S, Uribe-Vallejo A, Ramirez-Godoy A, Restrepo-Diaz H. Effect of kaolin application on growth, water use efficiency and leaf epidermis characteristics of *Physalis peruviana* L. seedlings under two irrigation regimes. Journal of Agricultural Science and Technology. 2015;17:1585-1596.
9. Singh R, Kumar S, Kumar H, Kumar M, Kumar A, Kumar D, Effect of irrigation and integrated nutrient management on water use efficiency and nutrient uptake of chickpea (*Cicer arietinum* L.). Plant Archives. 2017;17(2):1453-1456.
10. Swetha D, Hussain SA. Effect of moisture regimes on yield attributes, yield, nutrient uptake and quality of chickpea cultivars (*Cicer arietinium* L.). International Journal of Current Microbiology and Applied Sciences. 2017;6(9):3636-3645.
11. Tambussi EA, Bort J. Water use efficiency in C3 cereals under Mediterranean conditions: a review of physiological aspects. Annual Applied Biology. 2007;150:307-321.
12. Mansourifar H, Shi W. Deep synthetic minority over-sampling technique. arXiv preprint arXiv:2003.09788; c2020 Mar 22.