EFFECT OF FOLAIR APPLICATION OF GIBBERELLIN AND NUTRIENTS ON GROWTH AND YIELD OF POTATO VAR. "BURREN"

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ABSTRACT

The objective of this experiment is to investigate the effect of gibberellin and nutrients on growth and yield of potatoes. Factorial experiment (4 × 5) within randomized complete block design with three replications was carried out during two spring seasons (2016 and 2017) on potato plant var. Burren. The experiment for the first season was conducted in the fields of the Ministry of Agriculture while the season was at the fields of Agriculture College University of Baghdad. The experiment included foliar application of gibberellin using different concentrations 0, 50, 100, 200 mg.L^{-1} and symbolized as GA3(0), GA3(1), GA3(2) and GA3(3), respectively. The second factor was foliar two nutrients compositions separately where the first one was Disper at concentrations 1 and 2 g.L^{-1} and symbolized as D1 and D2, respectively while the other was Tecamine flower at concentrations 3 and 6 ml.L^{-1} and symbolized as T1 and T2, respectively in addition to the control treatment which symbolized as C0. Results showed that GA3(3)+D2 increased plant height (71.00 and 77.36 cm. plant^{-1} for the two seasons, respectively). The highest leaves area during the first season was at GA3(3)+T2 (2,823 m^2.plant^{-1}). The highest concentration of chlorophyll was at GA3(3)+T2 (478.9 and 462.6 mg.100 g^{-1} for the two seasons, respectively). The highest number of tubers was obtained in GA3(3)+ D2(13.2 and 9.21 tuber.plants^{-1} for the two seasons, respectively). GA3(3)+ T2 gave the highest tuber's weight during the first season (165.2 g. tuber^{-1}) while the highest plant yield was in GA3(3)+ D2 which reached 2.328 and 1.293 Kg. plant^{-1} for the two seasons, respectively. Therefore spraying with gibberellin or nutrients improved vegetative growth and increase yield of potato in the spring season for central region of Iraq.

Keywords: ***Solanum tuberosum*** **L, foliar, nutrient, gibberellin, yield.**
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تأثير الرش بالجبرلين والمغذيات في نمو وحاصل البطاطا صنف بورين

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المستلخص

تهدف الدراسة الى معرفة تأثير الرش بالجبرلين والمغذيات في نمو وحاصل البطاطا، نفذت تجربة عاملية (4×5) وفق تصميم القطاعات الكاملة المعشاة وبثلاث مكررات في الموسم الربيعي خلال السنتين 2016 و 2017 على صنف البطاطا بورين نفذ الموسم الاول في الحقول المكشوفة التابعة الى وزارة الزراعة والموسم الثاني في حقول كلية الزراعة – جامعة بغداد. تضمنت التجربة عاملين الاول فيها هو الرش بالجبرلين بالتراكيز 0، 50، 100، 200 ملغم . لتر$^{-1}$ رمز له (0) GA_3،(1) GA_3، (2) GA_3 و (3) GA_3 بالتتابع . والعامل الثاني هو الرش بالمغذين كلا على انفراد احدهما المحلول المغذي الداي سبر وبتركيزين 1 و 2 غم . لتر$^{-1}$ رمز له D1 و D2. والمحلول المغذي الاخر التيكامين فلاور بتركيزين 3 و 6 مل . لتر$^{-1}$ رمز له T1 و T2 بالاضافة الى المقارنة والتي رمز لها C0. أظهرت النتائج تفوق المعاملة GA3(3)+D2 في اعطاء اعلى ارتفاع بلغ 71.00 و 77.36 سم.نبات$^{-1}$ للموسمين بالتتابع واعلى قيمة للمساحة الورقية في الموسم الاول في المعاملة GA3(3)+T2 (2.823 م^2.نبات$^{-1}$) بينما كان اعلى تركيز للكلوروفيل في المعاملة GA3(3)+T2 (478.9 و 462.6 ملغم.100غم$^{-1}$ للموسمين بالتتابع). أعلى قيمة لعدد الدرنات عند المعاملة GA3(3)+D2 بلغت 13.2 و 9.21 درنة.نبات$^{-1}$ للموسمين بالتتابع. وفي معدل وزن الدرنة فقد تفوقت المعاملة GA3(3)+T2 في الموسم الاول (165.2 غم.درنة$^{-1}$) في حين اعطت المعاملة GA3(3)+D2 اعلى حاصل (2.328 و 1.293 كغم.نبات$^{-1}$ للموسمين بالتتابع). نستنتج من ذلك ان الرش بالجبرلين او بالمغذيات قد حسن من النمو الخضري وزيادة الحاصل للبطاطا المزروعة في الربيع وللمنطقة الوسطى من العراق

كلمات دالة: ***Solanum tuberosum*** **L**، الرش الورقي، جبرلين، مغذيات، انتاجية.
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INTRODUCTION

Potato (*Solanum tuberosum* L) is considered one of the most important vegetable crops in Iraq in terms of production and nutritional value, potato came forth among stable food after wheat, corn, and rice (10). Iraqi's farmland cultivated with potato about 6122 ha with a net production of 162915 ton (24.424 ton.ha^{-1}) in 2015 (11). Gibberellins, one of the plant hormones are synthesized and produced within different plant tissues including shoot and root tips and developed embryos. Their physiological effects represent in cell division and elongation in addition to inducing flowering and fruit set and growth (6). Otroshy and Struik (23) found that high concentration of gibberellin (5 mg.L^{-1}) caused a significant increase in the number of stems.plant^{-1}, plant height, and means tuber weight while 2.5mg.L^{-1} significantly affect to the number of tubers.plant^{-1} when applied to potato plants. Moreover EL-Helaly (12) found the treatment of potato tubers before planting with 5 and 7 mg.L^{-1} of gibberellin for 5 minutes led to increase in tuber weight, plant height, number of tubers, and plant yield. On other hand Geletie (14) used gibberellin with 0, 0.1, 0.2, and 0.3 mM on potato plants and noticed a significant increased when applied at 0.2 mM in plant height (126.40 cm.plant^{-1}) compared with the control which gave 85.10 cm.plant^{-1}. In general, plants required nutrients for growth and development. However, nutrients in the soil is not always available especially the micro elements that frequently leached, fixed, or adsorbed and therefore reduced in availability for the root system and that is why spraying can often considered as an alternative (26). Sahan (25) concluded that spraying with three types of nutrients compositions referred as Grow more (equal) at 2.5 g.L^{-1}, Grow more (high phosphorous) at 2.5 g.L^{-1}, and Sulo potash at 3 g.L^{-1} on potato plants led to significant increase in all parameters investigated at different developmental stages. In addition Majeed (20) showed that spraying with Vitorg on potato plants with 0, 3, 4.5, and 6 ml.L^{-1} during the spring season caused in a significant increases for the treatment at 6 ml.L^{-1} in plant height, number of leaves, leaf area, chlorophyll content, dry weight, number of tubers, tuber's weight, and yield.plant^{-1} (71.56 cm.plant^{-1}, 81.85 leaf. plant^{-1}, 5.52 shoot. plant^{-1}, 86.52 cm^2. plant^{-1}, 48.17 SPAD, 115.40 g. plant^{-1}, 7.77 tuber.plant^{-1}, 116.59 g.tuber^{-1}, 905.90 g.plant^{-1}, respectively). Several researchers (7, 8, 9 and 18) concluded that spraying with the nutrient solution on potato plants resulted in significant increase of some potato characters. The objective of this research is to examine the effect of gibberellin and nutrients on growth and yield of potato cultivar Burren.

MATERIALS AND METHODS

The experiment was carried out during two spring seasons (2016 and 2017) on potato plant var. Burren. The experiment was performed for the first season at the fields of the Ministry of Agriculture, Iraq and for the second season in the fields of the College of Agriculture - University of Baghdad. The land was divided to three blocks at 50 and 34 m in lengths, 60 and 50 cm in widths, and spaced 80 and 60 cm in-between blocks for two seasons respectively and the distance among plants was 30 cm. The tubers were planted in 25 Jan. 2016 and 10 Feb. 2017 for two seasons respectively. The experiment included two factors where the first was spraying Gibberellin at concentrations 0, 50, 100, and 200 mg.L^{-1} symbolized as GA3(0), GA3(2) and GA3(3) respectively and firstly applied after emergence (month after planting) and continued spraying every 15 days for three time. The second factor was spraying two nutrients separately, first one named Disper nutrient (26.30% algae extracts, 8% amino acids, 4.30%P_2O_2, 4.80% K_2O, 1.71% Zn, 0.27% B, 0.30%Mo) at concentrations 1 and 2 g. L^{-1} and symbolized as D1 and D2. The second nutrient named Tigamine Flower (3.8% N, 12.8% P_2O_2, 1.3% B, 0.6% Mo and 3.8% free amino acids) at concentrations 3 and 6 ml. L^{-1} and symbolized as T1 and T2 in addition to control treatment which symbolized as C0. Each nutrient was applied three times (after five days of spraying gibberellin). The experimental design was factorial experiment with Randomized Complete Block Design with three replications and eight plants for each experimental unit. Collected data were analyzed using Genstat statistical program and means were compared using least significant difference (LSD) test at 5% probablity (4). A

random sample of five plants from each experimental unit was collected at the end of the season to study morphological characters, such as main stem height (cm.plant^{-1}), number of main stems (stem.plant^{-1}), number of leaves, leaves area (m^2.plant^{-1}) which was calculated using the Digimazer program. Chlorophyll concentration was estimated according to Goodwin (14), and the percentage of the dry matter for vegetative growth, number of tubers (tuber.plant^{-1}), tuber's weight (g. tuber^{-1}), plant yield (kg.plant^{-1}) and productivity (ton.ha^{-1}).

RESULT AND DISCUSSION

Effect of gibberellin on vegetative traits

Results in table 1 show significant differences between the two experimental factors on vegetative growth characters of potato plant for both seasons. Spraying potato plants with gibberellin GA3(3) showed a significant increase in plant height (66.19 and 71.38 cm.plant^{-1}) for the two seasons respectively in comparison with GA3 (0) which had the lowest values (45.42 and 53.21 cm.plant^{-1} for the two seasons, respectively). The treatment GA3(2) significantly increased number of main stems in the first season (3.76 stem.plant^{-1}) while GA3 (3) increased this trait in the second season (3.43 stem. plant^{-1}). GA3(3) also significantly increased number of leaves in both seasons which reached 108.7 and 130.84 leaves.plant^{-1} for the two seasons, respectively, but non-significant difference was exhibited between GA3(2) and GA3(3) in the first season. This increase caused by GA3(3) increased leaf area recording 2.344 and 1.849 m^2.plant^{-1} for both seasons. GA3(3) application significantly increase total chlorophyll concentration of the plant reached 455.7 and 429.07 mg.100g^{-1} for the two seasons, respectively. These results were in agreement with the results of other researchers (2, 3, and 17) on potato plants. The improvement of vegetative growth traits after spraying with gibberellin may be due to its role in increasing cell division and elongation, or may be to stimulating production of auxin and increase activation of enzymes responsible for cell division and elongation (26). On the other hand, gibberellin may inhibit the destruction of chlorophyll and delays aging (6) and therefore increasing plant height and number of stems and leaves which relatively increase the leaf area. Results in Table 3 indicate that GA3(3) significantly increased dry weight to 24.61 and 21.36 g.plant^{-1} for the two seasons, respectively compared with control GA3(0) which reached 15.67 and 13.01 g.plant^{-1} for the two seasons, respectively. It can be concluded that the physiological effects of gibberellin on plant growth and its role in photosynthesis and activation of other functions of plant cell parts which increase both cell division and cell elongation (6) while the increasing of plant height, number of stems, number of leaves and leaf area (Table 1) led to increase dry weight of the plants all.

Effect of nutrients on vegetative traits

Nutrients showed a significant effect on plant height, D2 was superior compared with the other treatments, it gave 58.33 cm.plant^{-1} for the first season compared with the other treatments and control reached 51.58cm.plant^{-1} while T1 was superior compared with control in the second season in the terms of increasing plant height (64.02 and 56.71 cm.plant^{-1} respectively). The treatments D2 and T2 significantly increased number of stems when compared to control (3.75, 3.33 and 2.12 stem.plant^{-1}, respectively) for the first season and (2.97, 3.03 and 2.44 stem.plant^{-1}, respectively) for the second season. D2 during the first season and T2 on the second were significantly superior in number of leaves (111.36 and 110.46 leaves.plant^{-1}, respectively), while control produced (88.48 and 92.52 leaves.plants^{-1} for the two seasons, respectively). This caused a significant increase in leaf area which reached the highest value in the first season 1.808 m^2.plant by T2 treatment and in the second season reached 1.273 m^2.plant^{-1} by T1 treatment compared to control which amounted 1.3 56 and 0.871 m^2.plant^{-1}, respectively. The concentration of chlorophyll significantly increased by T2 (417.5 and 331.52 mg.100g^{-1} for the two seasons, respectively), compared with control (387.8 and 277.93 mg.100 g $^{-1}$ for the two seasons, respectively). Increased growth by nutrient may be due to its effectiveness in plant processing of essential nutrients during plant growth particularly when applied to meet plant's demand (19). In addition, nutrients play a major role especially those contains amino

acids in their formulations that contribute in the metabolic processes and energy production and synthesis of protein within plant tissues (24). Increased leaf content of chlorophyll due to nutrient spraying can be attributed to nutrient harboring growth-promoting substances and nutrients that promote vegetative growth and thus increase chlorophyll in leaves (22). In addition, spraying potato plant with nutrients resulted in a significant increase in dry weight of the plant (table 3) which recorded the highest value when spraying with T2 (20.61 and 18.54 g.plant^{-1}for the two seasons, respectively) compared with the lowest value in control (16.76 and 15.74 g.plant^{-1} for the two seasons, respectively). Plant dry mass is the final result of plant growth rate which includes many physiological processes that effect plant height, number of stems, leaves and vegetative dry matter which considered the most important indicators of growth status (13).

Effect of interaction on vegetative traits

Results in Table 2 indicate a significant effects of interaction between the gibberellin and nutrients in vegetative growth traits. The highest plant height value at GA3(3)+D2 was 71.00 and 77.36 cm.plant^{-1} for the two seasons, respectively while GA3(0)+C0 has the lowest value of 40.50 and 50.31 cm.plant^{-1} for the two seasons, respectively. During the second season, GA3(3)+D2 had 4.08 stem.plant^{-1} compared to GA3(0)+C0, where it had 2 and 2.2 stem.plant^{-1} for the two seasons, respectively. The highest number of leaves was found in the first season at GA3(3)+D2 (123.8 leaf.plant^{-1}) and in the second season at GA3(3)+T2 (157.55 leaf.plant^{-1}) while control plants gave 83.2 and 78.4 leaf.plant^{-1} for the two seasons, respectively. The values of plant leaf area in the interaction varied between the highest values which was found in the first season by GA3(3)+T2 (2,823 m^2.plant^{-1}) and in the second season by GA3 (3) + T1 (2.192 m^2. Plant^{-1}) where the lowest value found in control plants of the first season which was (1.052 m^2.plant^{-1}) and in the second season by GA3(0)+D1 (0.455 m^2.plant^{-1}). Nevertheless, the highest concentration of chlorophyll was found when using GA3(3)+T2 (478.9 and 462.6 mg.100 g^{-1} for the two seasons, respectively), which significantly differed from all interactions for both seasons. The lowest value was observed in the first season by GA3(0)+D1 (350.1 mg.100 g^{-1}) and in the second season by GA3(0)+C0 (226.56 mg.100 g^{-1}). The interaction between gibberellin and nutrients in dry weight of plants, the results in (Table 4) produced the highest values in the first season by GA3(3)+D2, GA3(3)+T2 and GA3(3)+T1, with no significant differences between them (26.3, 26.77 and 26.03 g.plant^{-1}, respectively) while in the second season found in GA3(3)+T2 and GA3(3)+T1 (22.37 and 22.12 g.plant^{-1} respectively) compared to GA3(0)+CO which has the lowest value of dry weight in plant (14.16 and 10.45 g.plant^{-1} for the two seasons respectively).

Effect of gibberellin on yield and its component traits

Results in Table 3 show that productivity, plant yield, and yield components were significantly affected by gibberellin in both seasons. Spraying GA3(3) led to significant increase in number of tubers (13.39 and 8.35 tuber.plant^{-1}), tuber's weight (146.1 and 127.82 g.tuber^{-1}), plant yield (1.962 and 1.071 kg.plant^{-1}), and in productivity (93.452 and 51.054 ton.ha^{-1}) for the two seasons, respectively when compared with control which recorded the lowest value of these previously mentioned indicators of 10.44 and 5.78 tuber.plant^{-1}, 101.2 and 106.38 g.tuber^{-1}, 1.068 and 0.614 kg.plant^{-1}, and 50.326 and 29.283 ton.ha^{-1} for the two seasons, respectively. These results similar with results of other researchers (2, 3 and 12). The phenotypic increased in these characters as affected by gibberellin mostly due to an increase in all the growth traits (Table1) that indirectly increased carbohydrates synthesis in the leaves, afterwards, transferred to tubers. This process increases tuber's number as well as weight which caused positively increasing productivity in unit area. Yield is the final outcome of its components which associated with numerous plant physiological and biochemical processes that occur within the tissues during many plant growth stages.

Effect of nutrients on yield and its component traits : Results in Table 3 show that yield and its components were significantly affected by nutrients in both seasons. D2 produced the highest number of

tubers in the first season (12.28 tuber.plant^{-1}) while T2 and D2 gave the highest value in the second season with no significant differences between them (7.36 and 7.02 tuber.plant^{-1}, respectively), when compared to control which gave the lowest value of 11.22 and 6.44 tuber.plant^{-1} for the two seasons, respectively. Tuber's weight was highest during the first season when spraying with D2, T2 and T1, with no significant differences observed between them (127.6, 125.9 and 121.4 g.tuber^{-1}, respectively) and in the second season when spraying with D2 which was 120.78 g.tuber^{-1} while the lowest value of tuber weight was found in control treatment (C0) reached 116.1 and 113.97 g.tuber^{-1} for the two seasons, respectively. These results were reflected on plant yield where the highest values were found in the first season at D2 which reached 1.594 kg.plant^{-1} , while in the second season were (0.891 and 0.87 kg.plant^{-1}, respectively) for both D2 and T2 with no significantly differences between them, while the value of yield significantly decreased in control (C0) which reached in the first season to 1.311 kg.plant^{-1} and to 0.738 kg.plant^{-1} on the second season. These results in accordance with other researchers (1, 5, 16 and 21) when they sprayed different nutrients on potato plant. Nutrient factor improved the vegetative growth of potato plants as it increases height, number of stems and number of leaves (Table 1) which were reflected in increasing assimilates synthesized in leaves and transferred to tubers. This increase in number of tuber and weight will positively increase yield. These increases in vegetative growth may be due to the fact that nutrients had supplied plants with crucial substances that participate in the biological processes within the plant such as photosynthesis, and synthesizing nucleic acids that are necessary for cell division (26).

Effect of interaction on yield and its component traits

Results in Table 4 indicate a significant increase of interaction between gibberellin and nutrients in yield and its components. The highest number of tubers was at GA3(3)+D2 which gave 13.2 and 9.21 tuber.plant^{-1} for the two seasons, respectively, while number of tubers reached up to 9 tuber.plant^{-1} during the first season at GA3(1)+C0 and to 5.31 tuber.plant^{-1} for the second season in control plants. As for the weight of the tubers, the results indicated that GA3(3)+D2 and GA3(3)+T2 were significantly highest than other interactions in the first season (165.2 and 155.5 g.tuber^{-1} respectively), and in the second season at GA3(3)+D2 (140.4 g.tuber^{-1}) in comparison with control (GA3(0)+C0) in which weight of the tuber reached to 99.2 and 105.37 g.tuber^{-1} for the two seasons, respectively. These increases caused an increase in yield of plant. The highest values of plant yield was at GA3(3)+D2 (2.328 and 1.293 kg.plant^{-1} for the two seasons, respectively while the control gave the lowest values (1.011 and 0.055 kg.plant^{-1} for the two seasons, respectively. In conclusion, response of potato plant var. Burren to spraying with gibberellin or nutrients Disper and Tigamine flower improved traits of vegetative growth reflected in increasing yield and productivity in the spring season for central region of Iraq. Therefore, we recommend spraying with gibberellin at 200 mg.l^{-1} and Disper at 2 g.l^{-1} or Tigamine flower at 6 ml.l^{-1} for more than one time during potato growing season to increase production.

Table 1. Effect of gibberellin and nutrients on vegetative growth characteristics of potato plant var. Burren grown in spring season 2016 (values up) and 2017 (values down).

Vegetative Growth Characteristics→ Gibberellin / mg.l^{-1}	Height of main stem (cm)	No. of stem (stem.plant^{-1})	No. of leaves (leaf.plant^{-1})	Leaves area (M^2.plant^{-1})	Conc. Of chlorophyll (mg.100g^{-1})
GA3 (0)	45.42	2.60	91.01	1.076	357.10
	53.21	2.32	80.51	0.618	240.24
GA3 (1)	51.02	2.82	97.49	1.330	388.10
	58.54	2.57	87.57	0.832	267.79
GA3 (2)	55.24	3.76	108.52	1.680	412.50
	61.48	2.74	100.21	1.093	299.42
GA3 (3)	66.19	2.88	108.70	2.344	455.70
	71.38	3.43	130.84	1.849	429.07
L.S.D. (0.05)	2.02	0.38	2.00	0.082	7.43
	1.95	0.20	2.14	0.038	3.81
Nutrients					
Control (C0)	51.58	2.12	88.48	1.356	387.80
	56.71	2.44	92.52	0.871	277.93
Disper (D1)	54.08	2.92	99.28	1.583	396.30
	59.17	2.52	95.12	0.970	305.14
Disper (D2)	58.33	3.75	111.36	1.631	403.70
	62.44	2.97	101.60	1.169	309.68
Tigamine flower(T1)	53.30	2.95	103.30	1.659	411.60
	64.02	2.87	99.20	1.273	321.38
Tigamine flower(T2)	55.10	3.33	104.72	1.808	417.50
	63.43	3.03	110.46	1.206	331.52
L.S.D. (0.05)	2.25	0.43	2.23	0.092	8.30
	2.18	0.22	2.40	0.042	4.26

Table 2. Effect of interaction between gibberellin and nutrients in vegetative growth characteristics of potato plant Var. Burren grown in spring seasons 2016 (values up) and 2017 (values down).

vegetative growth characteristics→ Interaction↓	Height of main stem (cm)	No. of stem (stem.plant^{-1})	No. of leaves (leaf.plant^{-1})	Leaves area (M^2.plant^{-1})	Conc. Of chlorophyll (mg.100g^{-1})
GA3 (0) +C0	40.50	2.00	83.20	1.052	343.10
	50.31	2.20	78.40	0.703	226.56
GA3 (1) +C0	50.40	2.20	88.60	1.126	377.30
	54.16	2.36	84.60	0.521	228.71
GA3 (2) +C0	50.10	2.20	90.90	1.671	390.10
	58.61	2.50	90.30	0.958	275.78
GA3 (3) + C0	65.30	2.10	91.23	1.576	440.60
	63.76	2.70	116.80	1.302	380.58
GA3 (0) + D1	42.30	2.30	90.60	1.062	350.10
	53.40	2.30	80.42	0.455	239.45
GA3 (1) +D1	50.80	2.60	103.45	1.133	379.40
	56.33	2.40	85.93	0.714	264.90
GA3 (2)+D1	55.20	4.10	110.30	1.792	412.70
	59.12	2.60	93.72	1.028	297.10
GA3 (3) +D1	68.00	2.70	92.77	2.344	442.80
	67.82	2.80	120.40	1.686	419.10
GA3 (0) + D2	49.60	3.30	95.53	1.067	360.30
	53.50	2.13	78.92	0.730	236.95
GA3 (1) + D2	52.40	4.00	110.60	1.144	380.00
	57.43	2.86	87.64	0.865	271.92
GA3 (2) +D2	60.30	4.30	115.50	1.663	413.80
	61.45	2.80	100.81	1.084	286.68
GA3 (3) +D2	71.00	3.40	123.80	2.652	460.50
	77.36	4.08	139.03	2.000	443.19
GA3 (0) +T1	46.30	2.40	93.30	1.124	360.00
	54.13	2.50	81.12	0.645	254.00
GA3 (1) + T1	50.50	2.30	90.20	1.692	416.30
	66.60	2.53	88.37	1.180	297.57
GA3 (2) + T1	53.40	4.10	112.40	1.496	414.40
	62.74	2.80	106.90	1.078	294.05
GA3 (3) +T 1	63.00	3.00	117.30	2.324	455.50
	72.62	3.67	120.40	2.192	439.90
GA3 (0) +T2	48.40	3.00	92.40	1.077	372.2
	54.72	2.50	83.70	0.559	244.24
GA3 (1) +T2	51.00	3.00	94.60	1.554	387.40
	58.20	2.70	91.29	0.880	275.83
GA3 (2) + T2	57.20	4.20	113.50	1.777	431.50
	65.47	3.00	109.31	1.319	343.40
GA3 (3) + T2	63.80	3.10	118.40	2.823	478.90
	75.32	3.92	157.55	2.067	462.60
L.S.D	2.02	0.86	4.47	0.184	16.61
0.05	1.95	0.45	4.80	0.085	8.52

Table 3. Effect of gibberellin and nutrients on dry weight and yield traits of potato plant var. Burren grown in spring season 2016 (values up) and 2017 (values down)

Traits studied→ Gibberellin	Dry weight (g.plant^{-1})	No. of tuber (tuber.plant^{-1})	Weight of tuber (g.tuber^{-1})	Yield of plant (kg.plant^{-1})
GA3 (0)	15.67	10.44	101.20	1.068
	13.01	5.78	106.38	0.614
GA3 (1)	17.31	11.00	115.60	1.269
	15.87	6.57	112.77	0.741
GA3 (2)	19.08	12.35	124.00	1.531
	18.84	7.15	119.50	0.855
GA3 (3)	24.61	13.39	146.10	1.962
	21.36	8.35	127.82	1.071
L.S.D. (0.05)	0.86	0.17	8.23	0.010
	0.66	0.16	2.64	0.023
Nutrients				
Control(C0)	16.76	11.22	116.10	1.311
	15.74	6.44	113.97	0.738
Disper (D1)	18.66	11.58	117.60	1.373
	16.35	6.75	115.63	0.786
Disper (D2)	19.92	12.28	127.60	1.594
	17.74	7.26	120.78	0.891
Tigamine flower(T1)	19.87	12.00	121.40	1.473
	17.98	7.02	115.73	0.816
Tigamine flower(T2)	20.61	11.89	125.90	1.536
	18.54	7.36	116.97	0.870
L.S.D. (0.05)	0.97	0.19	9.20	0.012
	0.73	0.18	2.95	0.026

Table 4. Effect of interaction between gibberellin and nutrients on dry weight and yield traits of potato plant var. Burren grown in spring season 2016 (values up) and 2017 (values down)

Traits studied→ Interaction↓	Dry weight (g.plant^{-1})	No. of tuber (tuber.plant^{-1})	Weight of tuber (g.tuber^{-1})	Yield of plant (kg.plant^{-1})
GA3 (0) +C0	14.16	10.20	99.20	1.011
	10.45	5.31	105.37	0.055
GA3 (1) +C0	14.92	9.00	112.50	1.185
	15.19	6.33	110.37	0.698
GA3 (2) +C0	17.82	10.30	120.50	1.379
	17.00	6.41	116.73	0.748
GA3 (3) + C0	20.13	12.00	132.20	1.669
	20.31	7.70	123.40	0.950
GA3 (0) + D1	16.18	10.30	100.60	1.049
	11.32	5.41	107.47	0.581
GA3 (1) +D1	17.10	9.20	112.40	1.209
	15.86	6.70	112.37	0.752
GA3 (2)+D1	18.18	11.40	122.40	1.504
	17.84	7.04	118.40	0.833
GA3 (3) +D1	23.18	12.10	135.10	1.729
	20.40	7.87	124.30	0.978
GA3 (0) + D2	16.28	10.50	102.60	1.076
	13.78	6.00	107.58	0.645
GA3 (1) + D2	17.41	9.30	118.90	1.355
	15.99	6.73	114.73	0.771
GA3 (2) +D2	19.08	11.90	123.60	1.618
	19.99	7.10	120.43	0.855
GA3 (3) +D2	26.92	13.20	165.2	2.328
	21.60	9.21	140.40	1.293
GA3 (0) +T1	15.32	10.30	101.30	1.073
	14.00	6.08	106.00	0.644
GA3 (1) + T1	18.23	9.30	116.80	1.284
	16.01	6.50	115.60	0.750
GA3 (2) + T1	19.91	11.50	125.10	1.614
	19.79	7.40	120.73	0.893
GA3 (3) +T 1	26.03	12.50	142.40	1.921
	22.12	8.11	120.60	0.978
GA3 (0) +T2	16.40	10.50	102.50	1.130
	15.50	6.10	105.50	0.643
GA3 (1) +T2	18.88	9.40	117.50	1.315
	16.30	6.63	110.77	0.734
GA3 (2) + T2	20.40	11.80	128.30	1.540
	20.00	7.81	121.20	0.946
GA3 (3) + T2	26.77	12.70	155.50	2.161
	22.37	7.90	130.41	1.160
L.S.D	1.94	0.38	18.39	0.024
0.05	1.47	0.37	5.91	0.052

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