EFFECT OF NITROGEN FERTILIZER AND SUPPLEMENTARY IRRIGATION ON YIELD AND QUALITY OF SOME LOCAL BREAD WHEAT VARIETIES

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ABSTRACT

Wheat production under climate of northern Iraq depends mainly on annual rain quantity and its distribution. Generally the annual rate is low and poorly distributed ,as a result the yield is low and unstable. Accordingly it has been suggested that small amounts of supplementary irrigation (SI) can alleviate the adverse effects of such unfavorable rain pattern, moreover the optimum dose of nitrogen fertilization is an important factor boosting wheat production and improving quality. The purpose of this study was to investigate the effect of nitrogen fertilizer and abridged (SI) on yield and grain quality. Field experiments were performed during the growing season 2003-2004 at two locations laying out as split-split plot design in RCBD, involving four promising bread cultivars as sub-sub plot, two levels of N fertilizer (zero and 80 kg N/ha) as sub-plot under rainfall alone and with (SI) as a main plot added at booting and heading stages at a rate of 25 mm for each stage. The results showed that N fertilizer had a significant effect on grain yield, grain protein content at both locations. The (SI) affected significantly number of grain/spike, grain yield, the interactions between factors were significant for most characters.

INRODUCTION

Wheat (*Triticum aestivum* L.) is the major cereal crop grown in Iraq, especially at northern regions mostly under rain fed condition therefore wheat production depends greatly on annual rainfall amount and distribution . At Ninevah governorate where the study was conducted the annual rainfall is about 350-500 mm and were usually poorly distributed, so the yield are rather low and unstable , the average of wheat yield under rainfall conditions for 1993-2003 was 179 kg/donum with great scattering range comprise from 51.3 to 415.3 kg/don. in 1999 and 2001, respectively (Statistic Issue, 2003), information of previous studies showed that small amount of supplemental irrigation may alleviate the adverse effects of unfavorable rain pattern and leads to improve and stabilize wheat yield (Garabet *et al*., 1998b; Oweis *et al*., 1998; Oweis *et al*.,2000; Adary *et al*., 2002) . The aim of adding (SI) was to raise the productivity of wheat which suffering from shortage of moisture, for example the rain water use efficiency was raised from 9.1 to 15 kg/ha/mm by adding 68 mm of (SI) in Iraq (Adary *et al*., 2002) other results showed that addition of 73 mm of (SI) raised the productivity of wheat to about 67% in Jordan, adding 36 mm of (SI) raised the productivity to about 46% in Syria (Nosaif, 2002), (SI) as a practice is still unusual by local farmers, and they are unfamiliar with such system, therefore researches needs to optimize such practices. In addition to (SI), nitrogen fertilization was extensively used to improve yield and grain quality of wheat, but the response for nitrogen depends on rainfall amount or on irrigation, usually

sufficient amount of rain or irrigation raise the nitrogen use efficiency (Engel *et al.*,1993; Engel *et al.*, 2001; Garabet *et al.* 1998a).

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Furthermore, the response of wheat to nitrogen and irrigation depends on cultivars (Ottman *et al.*, 2000). The agriculture extension should play a role in transferring such results to farmers for adoption. According to literatures reported studies of the relationships between (SI) and nitrogen fertilization on wheat grain quality are rare, therefore the objective of this investigation was to study the effect of nitrogen fertilization and accompanying irrigation and their interaction on some grain quality properties and growth in addition to yield of four local promising bread wheat varieties (three of them are recently released).

MATERIALS AND METHODS

Field trails were carried out in 2003-2004 growing season at two locations (Mosul and Telkaef 30 km north Mosul), The experiments were designed as a split-split plot in RCBD with three replications, each replicate comprised of 16 plots (1×3) meters; 50cm apart and 150cm between irrigated and un-irrigated plots. Four promising bread wheat cultivars i.e. Abu-Ghraib/3, Tamouz/2, IPA/99 and Iraq were assigned to sub-sub plot, two nitrogen rates namely zero and 80kg N/ha as urea 45% N) were partitioned in two equal doses, the first dose was added during seed sowing and the second was added at tillers stage, as sub-plot , under rain alone and with (SI) as a main plot ; (SI) was applied at booting and heading stages at a rate of 25 mm for each stage using perforated bucket to resemble sprinkler irrigation. Telkaef field was sown before fall first rain at 20-11-2003, while Mosul field was sown at 11-12-2003 after fall of approximately 75 mm rain. The seeds were sown in plots as 5 rows, 20 cm between rows at a depth of 3-4 cm and at a rate of 100 kg/ha. The recorded characters were plant height, number of effective tillers/m^2 and grain yield kg/ha. The obtained grains from each treatment were sieved and cleaned manually. Grain nitrogen content was determined by using Micro Kjeldahl method according to (AACC 46-11, 1976) the crude protein percentage was calculated by multiplying the nitrogen percentage by nitrogen factor(5.7). Grain sample for each treatment was prepared and tempered to 15.5% moisture, thereafter, 100g of tempered wheat was ground using (Quadrumat Junior Mill, Germany), and finally sodium dodecyle sulphate sedimentation was calculated according to Axford *et al*.(1979).

RESULT AND DISCUSSION

Yield components: Application of nitrogen resulted in insignificant enhancement in number of spikes/m^2, number of grain/spike at both locations (Tables, 1and 2), similar results have been reported by Alkaff and Ba-Momin (1998) and Singh *et al.*(2003). Supplemental irrigation led to a significant increment in number of grain/spike and insignificant increment in number of spike/m^2 at Telkaef which was planted 22 days before Mosul site. Such results were argued by Al-Ma-mury (1986) Al-Rawi and Al-Hadethi (1988) and Alam *et al.*(2003). Cultivars showed significant differences in these characters at both

locations, IPA-99 variety recorded highest number of spike/m^2 at Telkaef site, while Iraq cultivar gave highest value for number of grain/spike at both locations which was significantly different from other cultivars this was related with reduction in number of spike/m^2 which led to minimize the competition on nutrient absorption from soil and those synthesized in plant as well. These results are in

general agreement to those of Klar and Hossokawa (1996) and Saleem *et al.* (2003) . The effect of interaction between irrigation and fertilizer was insignificant for number of spikes/m^2 at Telkaef location, although it caused a remarkable increment with (SI) or N fertilizer or both which was significant at Mosul location, maximum number of spike/m^2 was recorded for the combination of (SI) with N fertilizer which was (341.8-380) spikes/m^2 at Telkaef and Mosul respectively, number of grain/spike was increased at both locations with (SI) alone or (SI) with N fertilizer which reached 51.28 and 42.51 at Telkaef and Mosul, while least number of grain/spike was recorded with no irrigation and fertilizer which was 42.72 and 39.07 for both locations, respectively. The interaction between irrigation with cultivars was significant for most characters at both locations. IPA-99 gave highest number of spike/m^2 with (SI) at Telkaef, while Abu-Ghraib-3 was superior to other cultivars at Mosul site. The Least values were recorded for Iraq cultivar at both locations. This was inversely reflected on number of grain/spike, therefore, Iraq cultivar gave the highest number of grain/spike at both locations, as a result of decrease in number of spike/m^2 and weak competition on nutrient, the reverse was true. The interaction of fertilizer with cultivars behaved similar trend of the interaction of (SI) with cultivars. The second order interaction (cultivars × nitrogen × irrigation) showed that number of spikes/m^2, number of grain/spike increased gradually by adding N fertilizer, supplemental irrigation or both for all cultivars.

Grain yield: Grain yield increased significantly due to nitrogen application at both locations (Table 3), the percentage of such enhancement was 13.02% and 8.6% at Telkaef and Mosul site respectively . These results were confirmed by Ottman *et al.* (2000); Al-Haidary (2003); Boehm *et al.*(2004); and Hossain *et al.*(2004).

Table (1) : Effect of Nitrogen level, supplementary irrigation, cultivars and their interaction on number of spike/m^2.

Water level	Nitrogen level	Wheat cultivar				Water level x nitrogen level	Water level means	Nitrogen means
		Abu-Ghraib3	IPA-99	Tamouz-2	Iraq			
Telkafe								
Rain-fed	Zero N	312.3ab	329.3ab	318.0ab	243.6c	301.0a		
	80Kg N/ha	328.0ab	351.3a	334.6ab	259.3c	318.3a		
Rain-fed+(SI)	Zero N	337.6a	349.3a	341.3a	264.0c	323.0a		
	80Kg N/ha	360.6a	360.3a	362.0a	284.3bc	341.8a		
Rain-fed		320.1a	340.3a	326.6a	251.5b		309.6a	
Rain-fed + (SI)		349.1a	354.8a	351.6a	274.1b		332.4a	
	Zero N	325.0a	339.3a	330.0a	253.8b			312.0a
	80Kg N/ha	344.3a	355.8a	348.3a	271.8b			330.0a

Wheat cultivar means		334.6a	347.5a	339.1a	262.8b	Over all mean		321.0
Mosul								
Rain-fed	Zero N	368.3cd	334.3de	331.3de	255.3f	322.3c		
	80Kg N/ha	393.0a-c	364.3bd	353.0cd	264.6f	343bc		
Rain-fed+(SI)	Zero N	397.3a-c	378.3a-d	392.0a-c	279.3f	361.7ab		
	80Kg N/ha	421.6a	399.3a-c	412.3ab	287.0ef	380.0a		
Rain-fed		380.6ab	349.3bc	342.1c	260.0d		333.0a	
Rain-fed + (SI)		409.5a	388.8a	402.1a	283.1d		370.9a	
	Zero N	382.8ab	356.3b	361.6b	267.3c			342.0a
	80Kg N/ha	407.3a	381.8ab	382.6ab	275.8c			361.9a
Wheat cultivar means		395.0a	369.0b	372.1b	271.5c	Over all mean		351.9

Table (2) : Effect of Nitrogen level, supplementary irrigation, cultivars and their interaction on number of grain/spike

Water level	Nitrogen level	Wheat cultivar				Water level x nitrogen level	Water level means	Nitrogen means
		Abu-Ghraib3	IPA-99	Tamouz-2	Iraq			
Telkafe								
Rain-fed	Zero N	42.09 d-f	44.90 c-f	39.8 e	44.60 c-f	42.72 b		
	80Kg N/ha	45.07 c-f	45.40 c-f	40.19 ef	46.93 b-d	44.40 b		
Rain-fed+(SI)	Zero N	46.29 b-e	46.39 b-e	44.72 c-f	46.96 b-d	46.09 ab		
	80Kg N/ha	50.97 a-c	52.08 ab	49.00a-c	53.17 a	51.28 a		
Rain-fed		43.85c	45.15bc	39.73d	45.76bc		43.56b	
Rain-fed + (SI).		48.58ab	49.24ab	46.86a-c	50.07a		48.68a	
	Zero N	44.19 cd	45.65 b-d	42.00 d	45.78 b-d			44.40 a
	80Kg N/ha	47.97 a-c	48.74 ab	44.60 b-d	50.05 a			47.84 a
Wheat cultivar means		46.08 a	47.19 a	43.30 b	47.91 a	Over all mean		46.12
Mosul								
Rain-fed	Zero N	34.83 d	41.13 bc	36.96 d	43.36ab	39.07 b		
	80Kg N/ha	35.06 d	41.20 bc	37.66 cd	44.43ab	39.59 b		
Rain-fed+(SI)	Zero N	37.13 d	41.26 bc	37.96 cd	44.56ab	40.23 ab		
	80Kg N/ha	37.26 d	45.46 a	41.20 bc	46.13 a	42.51 a		
Rain-fed		34.95 e	41.16 bc	37.31 de	43.90 a		39.33 a	
Rain-fed + (SI)		37.20 de	43.36 ab	39.58 cd	45.35 a		41.37 a	
	Zero N	35.98 e	41.20 bc	37.46 de	43.96 a			39.65 a
	80Kg N/ha	36.16 e	43.33 ab	39.43 cd	45.20 a			41.05 a
Wheat cultivar means		36.07 d	42.26 b	38.49 c	44.62 a	Over all mean		40.35

Supplemental irrigation enhanced grain yield at both locations, the enhancement was 23.7 and 18.1% for Telkaf and Mosul respectively. These results are in general agreement with those of Engel *et al*. (2001); and Alam *et al.* (2003). It is obvious that

the effect of (SI) was approximately double of that caused by nitrogen application. It is well known that the moisture is the major limiting factor determining grain yield potential under arid and semi-arid regions .Cultivars were also significantly different in grain yield, IPA-99 gave highest grain yield at both location which were 4623, 4250 kg/ha at Telkaef and Mosul, respectively, while minimum yield was for Abu-Ghraib/3 and Iraq at both location. Differences between cultivars have been also reported by Klar and Hossokawa (1996) Al-Samaray (2002) Boehm *et al.* (2004) Beuerlein *et al*. (2004). Such differences are mainly due to their genetic potential, production capacity, and efficiency in speed of nitrogen absorption . Nitrogen fertilizer and irrigation interaction

significantly influenced grain yield at both locations they caused a linear increment with nitrogen or (SI) or both in comparison to control. Garabet *et al.* (1998b);and Oweis *et al.* (1998) obtained higher yield with nitrogen fertilizer and supplementary irrigation similarly, moreover Oweis *et al.* (2000) reported that such application should be combined with proper sowing date, which is obvious in the present study particularly at Telkaef location, since it was sown earlier than Mosul location. Cultivars by irrigation interaction was significantly affected grain yield, IPA-99 and Tamouz-2 gave higher yield with (SI) at both location, also all cultivars respond positively with nitrogen application at both location, similar results have been reported by Singh *et al.* (2003) . The second order interaction caused a gradual increase of yield in all cultivars with nitrogen or supplemental irrigation or both, and the highest value was for IPA-99 with nitrogen and irrigation for both locations. The supplemental irrigation improved the efficiency of nitrogen utilization, but the response depends on the cultivar absorbing ability, so the combination of the three factors is very important to achieve maximum benefits of increasing grain yield.

Table (3) : Effect of Nitrogen level, supplementary irrigation, cultivars and their interaction on grain yield kg/ha .

Water level	Nitrogen level	Wheat cultivar				Water level x nitrogen level	Water level means	Nitrogen means
		Abu-Ghraib3	IPA-99	Tamouz-2	Iraq			
Telkafe								
Rain-fed	Zero N	3549 gh	3948 ef	3761 gh	3497 h	3688 d		
	80Kg N/ha	3998 ef	4489 cd	4205 de	3906 e-g	4150 c		
Rain-fed+(SI)	Zero N	4484 cd	4725 bc	4680 bc	4285 de	4543 b		
	80Kg N/ha	5068 ab	5331 a	5223 a	4998 ab	5155 a		
Rain-fed		3773 de	4218 c	3983 cd	3701 e		3919 b	
Rain-fed + (SI).		4776 ab	5028 a	4951 a	4641 b		4849 a	
	Zero N	4016 de	4336 cd	4220 de	3891 e			4116 b
	80Kg N/ha	4533 bc	4910 a	4714 ab	4452 bd			4652 a
Wheat cultivar means		4275 b	4623 a	4467 a	4171 b	Over all mean		4384
Mosul								
Rain-fed	Zero N	3503 g	3910 e-g	3814 fg	3570 g	3699 d		
	80Kg N/ha	3834 e-g	4327 bc	4232 cd	3859 fg	4063 c		
Rain-fed+(SI)	Zero N	4166 de	4715 b	4636 bc	4154 d-f	4417 b		
	80Kg N/ha	4367 b-d	5130 a	5125 a	4380b-d	4750 a		
Rain-fed		3669 c	4118 b	4023 b	3714 c		3881 b	
Rain-fed + (SI)		4266 b	4922 a	4880 a	4267 b		4584 a	
	Zero N	3834 c	4312 b	4225 b	3862 c			4058 b
	80Kg N/ha	4101 bc	4728 a	4678 a	4120 bc			4407 a
Wheat cultivar means		3967 b	4250 a	4451 a	3991 b	Over all mean		4232

Protein content % and sedimentation value: Application of nitrogen increased significantly protein percentage at both locations, such results are in general agreement to those of Abbasi *et al.* (1991); Teama *et al.* (1993) and Ottman *et al.* (2000). Sedimentation value was similarly increased referring to association of sedimentation value with protein %. Irrigation has no influence on protein or sedimentation value at both locations (Tables 4 and 5). Wheat cultivars showed a significant difference in protein %, Iraq cultivar recorded highest value which

was 14.03 and 14.31% at Telkaef and Mosul, respectively; the lowest was for IPA-99 which was 13.11 and 13.25% at both locations, meanwhile Abu-Ghraib/3 and Iraq varieties recorded highest values of sedimentation at both locations which due to their higher protein content. Fertilizer and irrigation also affected these parameters significantly highest protein % and sedimentation value was for the treatment under rainfall with N fertilizer at both locations. Irrigation with cultivars interaction have a significant effect on protein% and sedimentation value, Iraq cultivar under (SI) gave highest protein % and sedimentation value. These results are supported by Al-Ani (1993)who reported that availability of adequate amount of moisture in soil caused increment in nitrogen uptake due to superior growth and roots penetration which increase total root depletion zone and led to absorb greater nitrogen by plant. Cultivars respond differently to N fertilizer at both locations in respect to protein%, Iraq cultivar showed highest protein % with N fertilizer which was 14.26 and 14.5 at Telkaef and Mosul respectively,

Table (4) : Effect of Nitrogen level, supplementary irrigation, cultivars and their interaction on Seed protein % .

Water level	Nitrogen level	Wheat cultivar				Water level x nitrogen level	Water level means	Nitrogen means
		Abu-Ghraib3	IPA-99	Tamouz-2	Iraq			
Telkafe								
Rain-fed	Zero N	13.11 de	12.56 e	13.22 de	13.50 b-d	13.09 b		
	80Kg N/ha	13.70 a-d	13.40 bd	13.65 a-d	14.40 a	13.78 a		
Rain-fed+(SI)	Zero N	13.10 de	13.18 de	13.30 c-e	14.09 a-c	13.42 ab		
	80Kg N/ha	13.29 c-e	13.30 c-e	13.61 b-d	14.12 ab	13.58 ab		
Rain-fed		13.40 c	12.98 c	13.43 bc	13.95 ab		13.44 a	
Rain-fed + (SI).		13.19 c	13.24 c	13.45 bc	14.11 a		13.50 a	
	Zero N	13.10 cd	12.87 d	13 26 b-d	13.79 ab			13.26 b
	80Kg N/ha	13.49 bc	13.35 b-d	13.63 bc	14.26 a			13.68 a
Wheat cultivar means		13.30 b	13.11 b	13.44 b	14.03a	Over all mean		13.47
Mosul								
Rain-fed	Zero N	13.08 d	13.00 d	13.31 cd	13.97 a-d	13.34 b		
	80Kg N/ha	13.55 b-d	13.19 d	13.60 b-d	14.62 a	13.74 a		
Rain-fed+(SI)	Zero N	13.20 d	13.11 d	13.51 b-d	14.27 a-c	13.52 ab		
	80Kg N/ha	13.41 b-d	13.68 a-d	13.71 a-d	14.39 ab	13.80 a		
Rain-fed		13.31 b	13.10 b	13.45 b	14.29 a		13.54 a	
Rain-fed + (SI)		13.30 b	13.40 b	13.61 b	14.33 a		13.66 a	
	Zero N	13.14 c	13.06 c	13.41 c	14.12ab			13.43 b
	80Kg N/ha	13.48 bc	13.44 c	13.65 bc	14.50 a			13.77 a
Wheat cultivar means		13.31 b	13.25 b	13.53 b	14.31 a	Over all mean		13.60

Table (5): Effect of Nitrogen level, supplementary irrigation, cultivars and their interaction on Sedimentation value/cm^3

Water level	Nitrogen level	Wheat cultivar				Water level x nitrogen level	Water level means	Nitrogen means
		Abu-Ghraib3	IPA-99	Tamouz-2	Iraq			
Telkafe								
Rain-fed	Zero N	71.1 c-e	68.60 h	70.56 d-f	71.46 b-e	70.43 b		
	80Kg N/ha	73.60 a	68.76 h	71.80 b-d	73.23 a	71.95 a		
Rain-fed+(SI)	Zero N	72.00 b-d	69.03 gh	69.53 f-h	72.03 bc	70.65 b		
	80Kg N/ha	73.43 a	70.23 e-g	70.93 c-e	72.83 ab	71.85 a		
Rain-fed		72.35 a	68.68 d	71.18 b	72.55 a		71.19 a	

Rain-fed + (SI).		72.71 a	69.63 c	70.23 c	72.43 a		71.25 a	
	Zero N	71.55 b	68.81 d	70.05 c	71.78 b			70.54 b
	80Kg N/ha	73.51 a	69.50 cd	71.36 b	73.23 a			71.90 a
Wheat cultivar means		72.53 a	69.15 c	70.70 b	72.50 a	Over all mean		71.22
Mosul								
Rain-fed	Zero N	71.60 a-d	68.76 e	69.83 c-e	71.13a-f	70.33 c		
	80Kg N/ha	72.86 ab	69.06 e	70.93 b-e	73.46a	71.58 a		
Rain-fed+(SI)	Zero N	72.16 a-c	69.76 de	70.06 c-e	72.23a-c	71.05 b		
	80Kg N/ha	72.76 ab	70.00 c-e	70.03 c-e	72.73ab	71.38 ab		
Rain-fed		72.23 a	68.91 b	70.38 b	72.30 a		70.95 a	
Rain-fed + (SI)		72.46 a	69.86 b	70.05 b	72.48 a		71.21 a	
	Zero N	71.88 ab	69.25 c	69.95 c	71.68 ab			70.69 b
	80Kg N/ha	72.81 a	69 53 c	70.48 bc	73.10 a			71.48 a
Wheat cultivar means		72.35 a	69.39 b	70.21 b	72.39 a	Over all mean		71.08

meanwhile IPA-99 gave least protein% without nitrogen which was 12.87 and 13.06 at both locations. Abu-Ghraib/3 and Iraq cultivar with N fertilizer recorded highest sedimentation value at both locations. The second order interaction showed that Iraq cultivar under rainfall with N fertilizer alone gave highest protein% at both locations which were 14.40 and 14.62% for Telkaef and Mosul, respectively; while IPA-99 recorded the least value with control which were 12.56 and 13.0% for the same locations, the highest sedimentation value was for Abu-Ghraib/3 and Iraq with N fertilizer and without (SI) which were 73.60 and 73.23 ml at Telkaef and 72.86 and 73.46 ml at Mosul, and this was accompanied with protein % content.

تأثير التسميد النيتروجين والري التكميلي في الحاصل والصفات النوعية لبعض الأصناف المحلية من حنطة الخبز الناعمة

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الخلاصة

تعتمد إنتاجية الحنطة في المناطق الديمية ومنها المنطقة الشمالية في العراق بشكل كبير على كمية الأمطار الساقطة وتوزيعها خلال موسم نمو المحصول ، وبالنظر لقلة كمية الهطول المطري وعدم انتظام توزيعه غالباً فأن الإنتاج متذبذب ومنخفض ، وقد يكون لإضافة كمية من الري التكميلي مقرونة بالسماد النتروجيني دوراً ايجابياً في استقرارية الإنتاج وتحسين نوعيته . استهدفت هذه الدراسة التعرف على تأثير إضافة كمية قليلة من الري التكميلي بالإضافة إلى السماد النتروجيني في صفات نمو النبات والحاصل ومكوناته والصفات النوعية للحبوب والطحين لأربعة أصناف من حنطة الخبز المحلية الواعدة . نفذت تجربة حقلية في الموسم الزراعي ٢٠٠٣/٢٠٠٤ في موقعين (الموصل وتلكيف) باستخدام القطع المنشقة لمرتين في تصميم القطاعات العشوائية الكاملة وتضمنت كل تجربة ثلاثة عوامل هي ، أربعة أصناف من حنطة الخبز المحلية (أبوغريب /٣ وإباء /٩٩ وتموز /٢ والعراق) وزعت على الألواح تحت الثانوية ، وضم العامل الثاني مستويين من السماد النتروجيني (صفر ، ٨٠كغم N /هـ) وزعت كألواح ثانوية أما العامل الثالث فقد أشتمل على إضافة الري التكميلي مع الأمطار ، أو بالاعتماد على الأمطار الساقطة لوحدها كألواح رئيسة. أظهرت النتائج بان إضافة السماد النتروجيني إلى زيادة معنوية في حاصل الحبوب والمحتوىالبروتيني في الحبوب وقيمة ترسيب البروتين في كلا الموقعين ، كما أدت إضافة الري التكميلي

إلى زيادة معنوية في حاصل الحبوب في كلا الموقعين و زيادة معنوية في عدد الحبوب / سنبلة في موقع تلكيف واختلفت الأصناف فيما بينها معنوياً في جميع ألصفات ، وكان للتداخل بين العوامل تأثير معنوي على جميع الصفات المدروسة ٠

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